VICON ENGINEERING

BEYOND MOTION

VICON TRACKER USER GUIDE

WHAT'S INSIDE

Revision 1. For use with Vicon Tracker 4.0.

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About this guide

The *Vicon Tracker User Guide* provides product information, user assistance, and operational expertise to help you capture and analyze motion data. It will help you confirm your basic understanding of any steps; investigate a process, step, or option in more detail; try more advanced features; or pick up best practice tips.

About Vicon Tracker documentation

The following documentation is available for the current Tracker release:

Document	Description
Tracker 4 Migration Guide	Helps you to transition from Tracker 3 to Tracker 4. PDF available from the Vicon documentation website[1] and as online help.
Vicon Tracker User Guide	Explains how to use Tracker with Vicon camera systems. PDF installed with Tracker, available from the Vicon documentation website and as online help.
Installing and licensing Vicon Tracker	Step-by-step instructions for installing and licensing Tracker. PDF available from the Vicon documentation website and as online help.
Vicon Tracker Python API Quick Start Guide	Introductory information to help you to start using the Vicon Tracker Application Programming Interface (API). PDF available from the Vicon documentation website and as online help.

1 https://docs.vicon.com

Regulatory information

For Vicon Tracker regulatory details, see Vicon Tracker regulatory information in the Tracker documentation area of the Vicon website[2].

2 https://docs.vicon.com

Introducing Vicon Tracker

Vicon Tracker is a powerful object-tracking solution, providing unrivaled data accuracy for integration into 3D applications. It enables you to use Vicon camera hardware for tracking rigid bodies, accurately streaming 6 Degrees of Freedom data in real time with very low latency.

To get started with Tracker, you set up your Vicon system and prepare objects for motion tracking.

For more information, see the following topics:

Prepare your Vicon Tracker system

Tracker is part of the fully integrated and expandable Vicon system that lets you build an architecture best suited to your motion capture application.

It is assumed that your Tracker system hardware components are connected to a power supply, and that Tracker is installed and licensed.

If you're installing your Tracker system yourself, see any Vicon documentation that was supplied with your hardware and Installing and licensing Vicon Tracker. If you need further help, please contact Vicon Support[3].

In the following topology diagram , Tracker is installed on the host PC.

For further examples of Vicon system topology, see Vicon system configuration and connection examples[4].

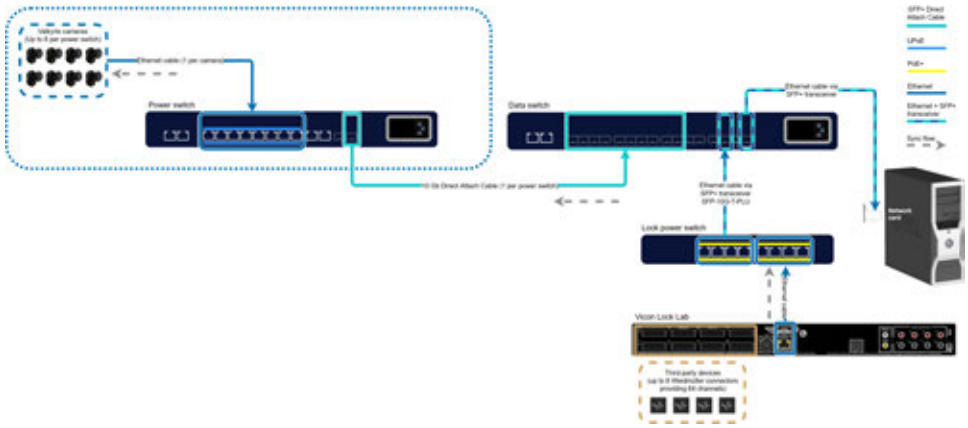
For more information on preparing to use Tracker, see:

- Tracker system architecture on page 9
- Tracker system components on page 10
- Connect cameras on page 13
- Start Tracker on page 14
- Save system settings on page 16
- Enable Tracker to track objects on page 16

3 mailto:support@vicon.com
4 https://docs.vicon.com/display/Connect/Vicon+system+configuration+and+connection+examples

Tracker system architecture

The following diagram shows an example of a Tracker system with up to 80 Vicon Valkyrie cameras and a Vicon Lock Lab for connecting analog devices.



In a system that requires more than one Ethernet switch:

- To ensure correct synchronization of your system, you must either:
  - Connect a Lock to the switch that is connected to the PC, known as the *primary switch*. (This can be via a Lock power switch, as shown in the above example.)
    or
  - Ensure that a camera connected to the primary switch is selected in the Vicon application software to be the **Sync Source**.

  In the above example, the Lock is the sync source and is connected via a Lock power switch to a data switch. For an explanation of the types of switches that can be included in a Valkyrie system see *Switches in Valkyrie systems* in the *Vicon Valkyrie Reference Guide* .
- If a camera is the sync source (the one that outputs the Vicon Ethernet sync packet), ensure it is connected to the primary switch.
- Up to 8 Valkyrie cameras can connect to the power switch and up to 10 power switches can connect to the data switch.

Remember that, when you connect switches, one port is taken on each switch in connecting the two, as shown in the above example.

Tracker system components

> **Note**
> Except where noted, references to Vicon Lock, Lock devices, and Lock apply to all current models of the Vicon Lock (at the time of publication, this includes Lock Studio and Lock Lab).

You can include the following components in a Vicon Tracker system architecture:

Component	Description
Valkyrie Cameras	Valkyrie cameras (VK26 and VK16) can be used with Tracker 4.0. You can use Valkyrie cameras with Vero, Vantage, Viper (including ViperX) and Bonita cameras in systems running Tracker 4.0 and later. **Caution:** If you add Valkyrie cameras to a system that includes T-Series cameras, the T-Series cameras will not work. See also the Vicon Valkyrie documentation.
Vicon Viper and ViperX cameras	Viper cameras and ViperX cameras can be used with Tracker 4.0. You can use Viper and ViperX cameras in systems running Tracker 3.8 and later. See also the Viper documentation, Connect cameras on page 13 and Configure Vicon cameras on page 84.
Vicon Vero cameras	Vicon Vero cameras (v1.3 and v2.2) can be used with Tracker 4.0. You can use Vicon Vero cameras in Vicon Valkyrie and Vantage systems. See also the Vero documentation, Connect cameras on page 13 and Configure Vicon cameras on page 84.
Vicon Vantage cameras	Vantage cameras (V16, V8, and V5) can be used with Tracker 4.0. See also the Vicon Vantage documentation, Connect cameras on page 13 and Configure Vicon cameras on page 84.

Component	Description
Vicon connectivity units	Vicon Lock devices facilitate the integration of synchronous third-party equipment with Vicon cameras by providing or receiving synchronization and/or timecode. Lock Lab also provides connectivity for third-party analog capture sources, such as force plates and EMG equipment. Connect to a PoE switch to which the host PC is connected. Vicon Lock Lab and Vicon Lock Studio are RoHS-compliant. See also Configure Vicon connectivity devices on page 99 and Configure analog devices on page 104.
Switches	Switches obtained from Vicon that may provide PoE, PoE+, UPoE, and SFP+ connectivity
Host PC	The main PC in the Vicon system, with at least one dedicated Ethernet port to enable Vicon system communications (in addition to any other network ports on the PC). Vicon Tracker application software is installed on this PC. Remote PCs may be used for other Vicon application software or third-party applications connected to the host PC via Ethernet.
Vicon cables	Proprietary Vicon cables plus commercially available Ethernet cables and transceivers connect Vicon system components, providing a combination of power, Ethernet communication, synchronization signals, and data.
Vicon calibration device	Specialized device used to accurately calibrate the Vicon system. See also Calibrating Vicon cameras on page 115.
Vicon accessories	Supplies for the Vicon system, including markers, tape, and Velcro.
Vicon engineering software	Vicon Tracker software, DataStream SDK and Vicon Virtual System.
Analog devices	Your Vicon system may also include one or more analog devices, such as LVDTs, accelerometers, and load cells. See also Configure analog devices on page 104.

For further details of these components, see the *Vicon Systems Setup Guide* , which can be downloaded from the Vicon documentation website (docs.vicon.com).

Vicon Tracker checks for supported Vicon devices before allowing connection. If your system contains non-supported devices, when you start Tracker, it displays a

message alerting you to the incompatibility and asks you to disconnect incompatible devices.

> ⚠ Before you begin, ensure that:
>
> - Any analog devices you want to use are connected to a Vicon Lock device.
> - The correct switch has been designated as the primary switch (ie, the switch that is directly connected to the PC that runs Tracker).
> - Vicon Lock devices are connected to the primary switch.
> - Your firmware is up to date (see Update system firmware on page 17).

Connect cameras

To connect cameras into your Vicon system, you must specify the correct IP address for the network port that is connected to the PoE switch.

For legacy videos that show you how to mount your cameras, see the Installation tutorials in the Tracker 3 Tutorials[5] playlist on YouTube.

To connect the cameras:

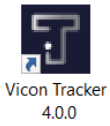
1. Connect the PoE switch to the PC.
2. Access the Windows network connections:
   - Open the **Control Panel**, then click **Network and Internet** and on the right side of the panel, under **Network and Sharing Center**, click **View Network Status and Tasks**; or
   - Click the **Network and Sharing Center** icon on the right of the Windows toolbar and then click **Open Network and Sharing Center**.
3. Right-click on the network card connected to PoE or Giganet and then click **Properties**.
4. In the **Properties** window, select **TCP/IP**.
5. Click the **Properties** button.
6. In the **Properties** window, click the **Use the Following IP Address** radio button.
7. Enter the following **IP address**: – 192.168.10.1.
8. Enter the following **Subnet Mask** – 255.255.255.0.
9. Click **OK**.

For more information, see also Configuring network card settings.

5 https://www.youtube.com/watch?v=q7XVOLF05M8&list=PLxtdgDam3USXPrhGA70ix8WT_nZBLK7qB

Start Tracker

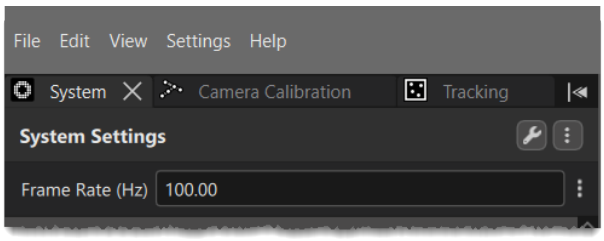
When you install Tracker, a Vicon Tracker shortcut appears on your Windows desktop (and an entry is added to the Windows Start menu).



Depending on the options selected during installation, you may also see an icon for Vicon Firmware Manager.

To start Tracker:

1. Double-click the Vicon Tracker shortcut.
2. Ensure the **System** panel is visible.

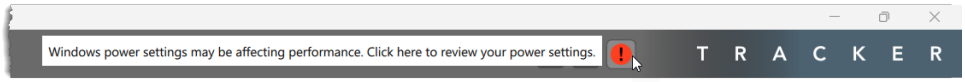


> **Tip**
> If you can't see the System panel, one way to display it is to select the Default view.
>
> To do this, on the right of the menu bar, click View Settings and then select **Default**.

From this panel, you monitor and control devices connected to the software.

Windows power options monitoring

When you first start Tracker, you may see a warning icon on the right side of the menu bar, like this:



This icon indicates that the current power plan is set to favor power savings over performance. The power-saving features of Windows can significantly reduce Tracker's performance and increase output latency, depending on the power plan that is chosen and the processor support for power-saving features.

For more information and access to the **Power Options** in the Windows Control Panel, click the icon.

For best performance, choose the **High performance** plan (or a plan created from the high performance plan).

Save system settings

When you have finished setting up your system, you can save your current settings so that you can re-use them in future. The settings that are saved include all device settings, system-wide settings (eg, frame rate), as well as processing parameters.

To save your current Tracker settings:

1. On the right of the Tracker menu bar, click System Settings  and then select **Manage**.
2. In the Manage System Settings dialog box, click the Save button and enter a name for your saved configuration.

The next time you need to reload your settings, you can select the saved configuration by clicking System Settings again and selecting your saved configuration.

Enable Tracker to track objects

Objects define a pattern of markers that Tracker can locate from camera centroid detections.

To enable tracking of objects, you must create objects in Tracker for each physical object that you want to track.

For more information, see Work with objects on page 174.

Update system firmware

Vicon hardware is programmed with firmware to control its operation. Periodically, Vicon supplies firmware updates to correct or improve device functionality. You apply these firmware updates to your Vicon hardware via the Vicon Ethernet network using the Vicon Firmware Manager, as described below.

You are automatically notified when any component of your Vicon system is running out-of-date firmware, and given the opportunity to update to the latest version.

> **Important**
> To ensure optimum performance and access to all the latest functionality, Vicon recommends that you upgrade to the latest firmware whenever it becomes available.

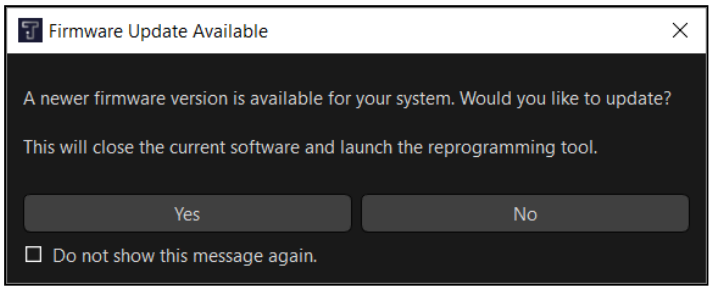
To monitor and/or upgrade system firmware:

1. When you start Vicon Tracker or connect any Vicon devices into your system, Tracker checks to see whether the system firmware is up-to-date.
   If your devices aren't using the latest firmware, Tracker displays a caution icon in the toolbar to let you know that a more up-to-date version of the firmware is available.
2. Do either of the following:
   - To display more information, click the icon.

     > **Tip**
     > Wait for all cameras to connect before clicking the toolbar icon.

     or
   - From the **Help** menu, select **Check for Firmware Updates**.

Tracker displays a prompt that enables you to open the Vicon Firmware Manager.

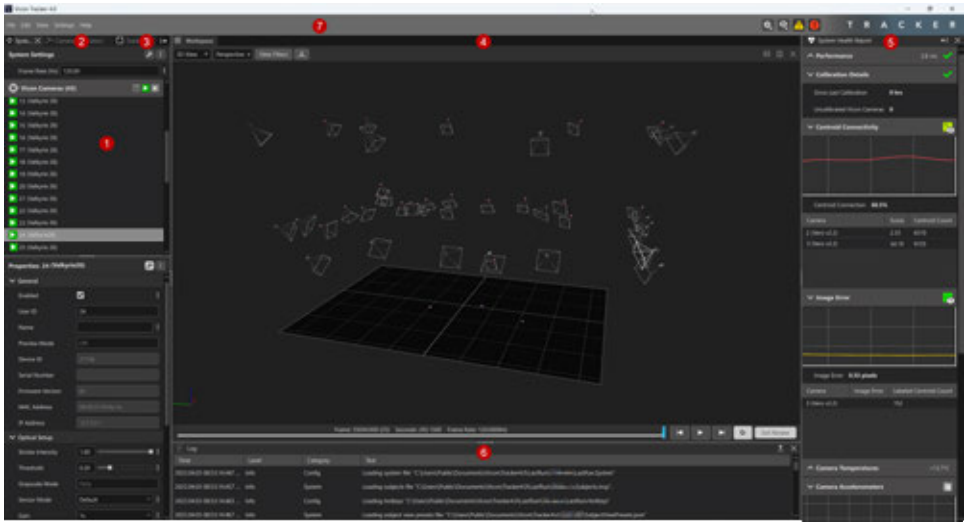


3. Click **Yes** to open the Vicon Firmware Manager and close Tracker. Note that you can also open the Vicon Firmware Manager from the **Start** menu (select **Vicon** > **Vicon Firmware Manager**).
   Tracker closes and the Vicon Firmware Manager is displayed, showing all the connected devices and their current firmware version.
   For guidance on how to use Vicon Firmware Manager, see the Vicon Firmware Manager Quick Start Guide[6] .
4. When finished updating, close Vicon Firmware Manager.
   If you opened Vicon Firmware Manager from Tracker directly, Tracker will restart when the Vicon Firmware Manager is closed.

6 https://docs.vicon.com/display/FirmwareManager

Get to know Tracker

The Tracker user interface guides you through common tasks.



By default, the following panels are displayed as tabs on the left of the Tracker window:

1 **System** panel: Enables you to set up and manage the components of your Vicon system.
For more information, see Configuring your Vicon Tracker system on page 78.

2 **Camera Calibration** panel: View and select options relating to calibrating the cameras. For more information, see Calibrating Vicon cameras on page 115.

3 **Tracking** panel: Import, create and manage objects whose motion data you want to track, and control tracking. For more information, see Setting up object tracking on page 173.

By default, the following panels are displayed in the center of the Tracker window:

4 **Workspace**: Set up the way you want to visualize capture data from one or more cameras. For more information, see Viewing system data on page 34.

5 **System Health Report** panel: Enables you to monitor the health of your system. For more information, see System Health Report on page 164.

6 **Log**: View messages about the current status of your Vicon system. For more information, see Monitoring system activity on page 252.

At the top of the Tracker window, the menu bar provides access to the Tracker menus and settings:

7 **Menu bar**: Exit Tracker; undo/redo; open and close panels; set preferences, show hot keys and Vicon Control authorizations; and view help, software version, and licensing information. Also enables you to view, change and save system settings and window layouts (View settings). In addition, Tracker displays information that indicates the currently selected mode, such as Video Preview or Masking, etc. For more information, see About the menu bar on page 52.

To display the following panels, from the **View** menu, select the required option:

- **Capture** panel: Enables you to save captures for future review. For more information, see Capturing data on page 232.
- **Connections** panel: Enables you to view any connected clients, and to view and change settings for Vicon DataStream output, stream data using Open Sound Control, specify UDP object streaming protocol properties, and work with VRPN. For more information, see Extending your use of Vicon Tracker on page 260.
- **Processing** panel: Enables you to view and change system-wide settings for object tracking, camera healing, performance tuning, and more. For more information, see Configure system processing parameters on page 109.
- **Review** panel: Enables you to review data from previous captures. For more information, see Review captures on page 250.

When you are familiar with the Tracker user interface, you can customize Tracker to look and behave as you want (see Customize the Tracker user interface on page 24).

Next steps

Before you begin working with Tracker, it is important to understand the core fundamentals of how it operates (see Tracker fundamentals on page 21).

Tracker fundamentals

As you work through your Tracker session, it's important to understand these fundamental aspects of Tracker's behavior:

- Device synchronization session on page 21
- Live Review on page 22
- Autosave on page 22

Device synchronization session

When you connect Tracker to a live system of cameras and/or Vicon connectivity devices, a new device synchronization session is created. To identify the current device synchronization session, look in the timebar at the bottom of the Workspace for the value in brackets [ ].

When you start Tracker, the device synchronization session starts at 1 and the Frame and Seconds displayed are relative to the start of that session.

The device synchronization session enables the system to synchronize all devices. As such, a new system session starts when:

- The hardware is rebooted
- A device is added to the system
- The frame rate changes

Being aware of the device synchronization session, and the time or frame relative to its start, can be useful when:

- Plotting data (see Graphing your data on page 202)
- Exporting data (see Exporting data to CSV on page 256)
- Streaming data out of Tracker (see Extending your use of Vicon Tracker on page 260)

Live Review

When Tracker is live, the system's pause buffer is a feature that enables data to be stored to memory for Live Review (see Review live data on page 248). The maximum amount of data that can be stored is controlled by the **Pause Buffer Size**, which you can configure in the Processing panel (see Configure system processing parameters on page 109). The Pause Buffer Size specifies the duration of the pause buffer, and thus the amount of data that is always accessible.

The data types stored in the pause buffer are identical to the data types that are saved when capturing data. This includes data such as, but not limited to, centroids in each camera view, object pose, analog devices, and system performance metrics such as latency. For more information on the data types that are stored in a capture, see Capture live data on page 234.

The pause buffer influences the behavior and workflow of multiple aspects of the software including:

- Object creation and manipulation
- Reviewing recent live data
- Graph Plots
- CSV exports

Autosave

With Tracker started, its default behavior is to save all settings automatically according to the **Auto-save interval** setting (see Preferences options on page 59), which is the duration of time between each save operation. Autosaved settings do not affect any of the saved system settings.

All autosaved files are located within this folder:

C:\Users\Public\Documents\Vicon\Tracker4.#\LastRun\username

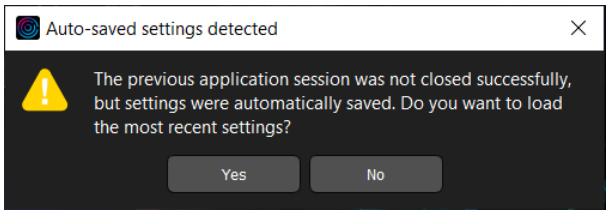
> **Note**
> Autosave files are only updated if there have been changes since the last autosave.

As you work in Tracker, files populate into the above folder according to the temporary filenames listed in the following table. When you close Tracker properly, the temporary filenames are converted and saved as normal filenames.

Temporary filename	Normal filename
AutoSave.System	LastRun.System
AutoSaveSubjects.mcp	Subjects.mcp
AutoSave.View	LastRun.View
AutoSave.HotKeys	LastRun.HotKeys

If Tracker terminates abnormally (including closing the process from Windows Task Manager), the temporary filename is not converted to its normal filename and thus is left in the *LastRun* folder.

When you restart Tracker, if any of the autosave files are detected, you are prompted to confirm which files you wish to load:



- To load the most recent (autosaved) settings, click **Yes**.
  or
- To load settings from the last successfully closed session, click **No**.

This feature prevents you from losing your settings if Tracker closes abnormally, for example, due to process termination, machine reboot, etc.

To control the autosave settings, select **Settings** > **Preferences** > **User**:

- To disable autosave, clear **Enable auto-save**. The default is selected.
- To change the autosave interval, enter a value (in seconds) for the **Auto-save interval**. The default is 60 seconds.

> **Note**
> If you have system settings that you are likely to re-use, we recommend that you save them, rather than relying on the autosave feature. For more information, see Save system settings on page 16.

Customize the Tracker user interface

You can customize the appearance of the Tracker window to suit your preferences, using any of the following procedures. Tracker maintains these settings until you adjust them again.

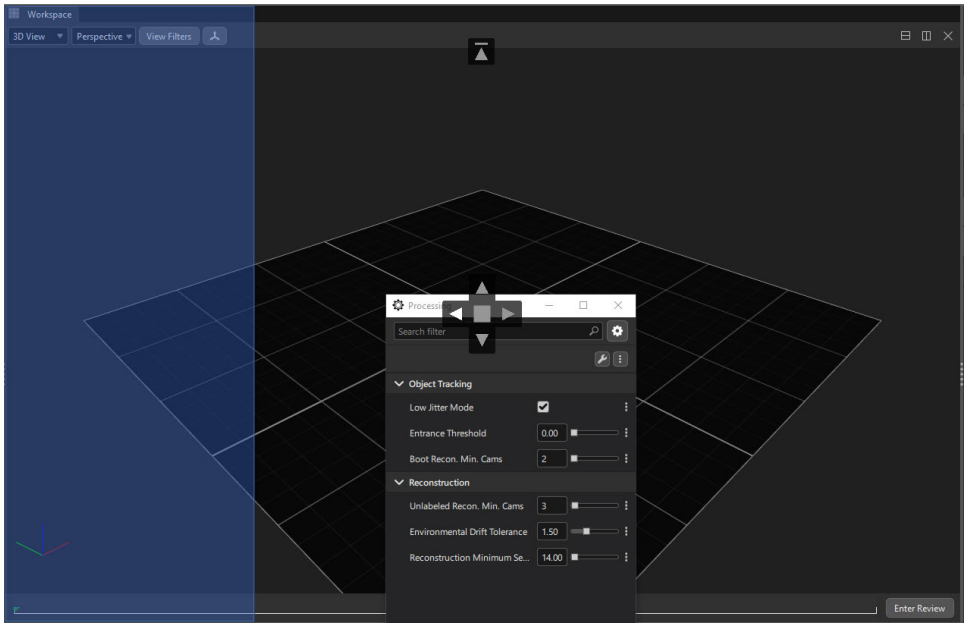
> **Tip**
> To revert to the default layout, on the right of the menu bar, click View Settings and select **Default**.

- Change the position of panels on page 25
- Hide and display panels on page 26
- Expand and collapse panel sections on page 27
- Customize views and layouts on page 28
- Search for properties in the Processing panel on page 33

Change the position of panels

In Tracker, you can position the panels to suit your way of working.

To move panels, drag them by their title bars and drop them into place using the guides that overlay the main window:



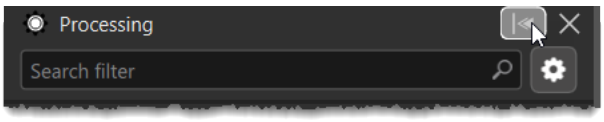
If you prefer, instead of docking the panels as described above, you can leave panels floating in an independent window.

Hide and display panels

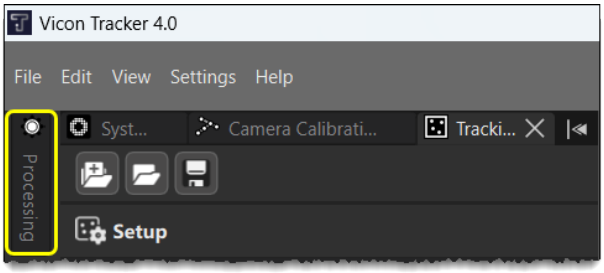
In addition to changing the position of panels (see Change the position of panels on page 25), you can also hide some panels, to give you more space in which to work.

To hide/redisplay a panel:

- On the title bar of a docked panel, click the **Pin** button.



The panel is hidden as a vertical tab along an edge of the main window.



If you hide multiple panels, they are tabbed vertically along the edge of the main window.

To re-display a pinned tab:

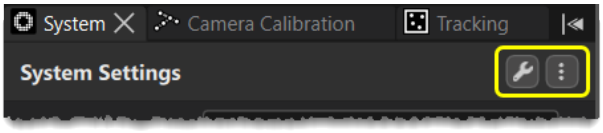
1. Click the required tab on the edge of the main window.
   The panel is displayed in a floating window.
2. To dock it again, click its **Pin** button.

Expand and collapse panel sections

Within each panel, you can expand and collapse sections, to make it easier to access the controls you want to use.

Operation	Mouse action
Expand section	Click the upward-pointing arrow
Collapse section	Click the downward-pointing arrow

To help you find the controls, panels also let you show and hide Advanced settings, and where applicable, you can set the values to their defaults.



Tip
The Workspace cannot be undocked or repositioned in the Tracker window. You can open a separate floating view pane by selecting the **Add floating workspace** option from the **View** menu. This floating workspace can be repositioned and resized.

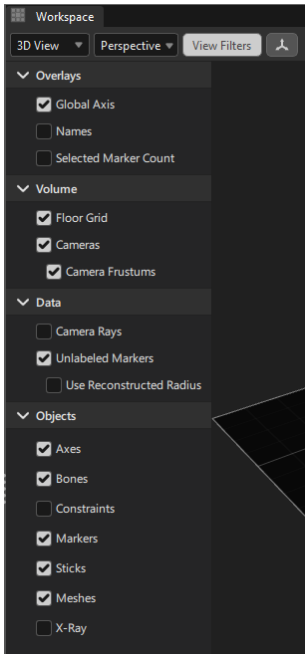
Customize views and layouts

Tracker provides you with a number of ways to customize both what you view in the Tracker Workspace and the layout of the windows. You can change and customize the view to suit your way of working.

Set appropriate View Filters

While you're working with Tracker, you can set the View Filters to give the most useful view of your data. **View Filters** are available for **3D View**, **Cameras**, and **Object** views.

The **View Filters** for the **3D View** include options for object tracking.



Your settings are automatically saved, so that you can easily re-use them for different workflows.

The view filter presets are stored in the view presets file, by default:

C:\Users\Public\Documents\Vicon\Tracker4.x\username*SubjectViewPresets.json*

The current view filter preset is stored in the view file, by default:

C:\Users\Public\Documents\Vicon\Tracker4.#\LastRun\username*LastRun.View*

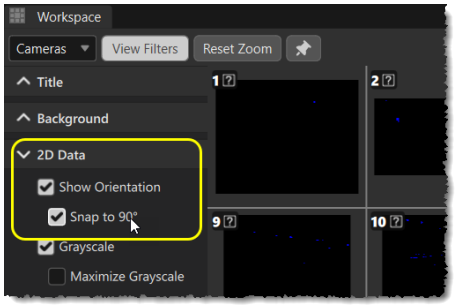
Change camera orientation detection

View frames in the Cameras view can be rotated to match their physical orientation, so that up in the image matches up in the real world. The orientation is determined from the camera calibration if available, otherwise the accelerometer on board the camera is used.

This option is enabled by default.

To turn on or off camera orientation detection:

1. In the **Cameras** view, click **View Filters**.
2. In the **2D Data** section, select or clear **Show Orientation**.
3. To choose whether to snap to 90° increments, ignoring smaller rotations, select or clear **Snap to 90°**.

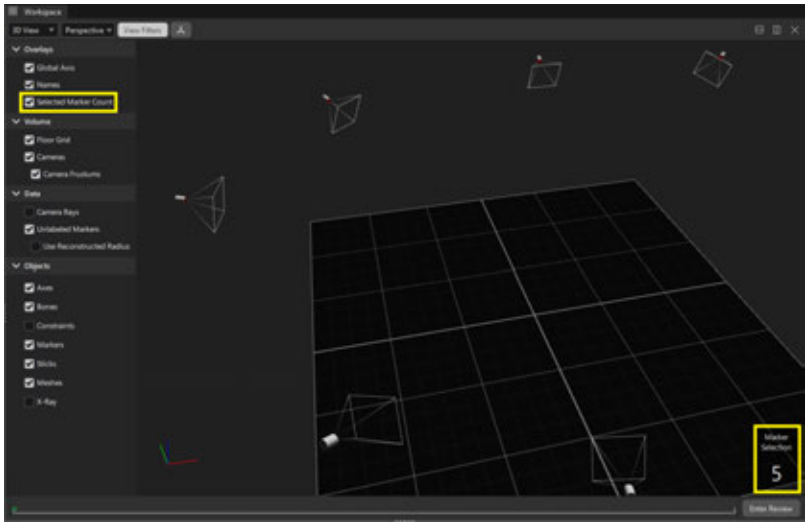


Display the number of selected markers

To quickly check that all markers on a particular target are visible, you can select an option in the **3D View** to show the number of markers currently selected.

To display the number of selected markers:

1. In the **3D View**, click **View Filters**.
2. In the **Overlays** section, select or clear **Selected Marker Count**.
   At the bottom right of the view pane, the **Marker Selection** count is displayed.
   If no markers are currently selected, a zero is displayed.



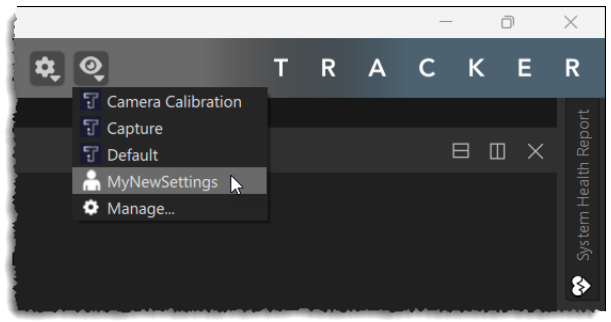
As you select markers, the Marker Selection counter changes to display the number of selected markers.

Save your window layouts

In addition to using the supplied Default tracking, Capture and Camera Calibration layouts, you can save your own customized layouts of the workspace and panels. This enables you to quickly switch between layouts when either setting up the system or object tracking.

The settings that are saved are those affecting panel visibility, geometry and settings that only affect the Tracker UI (graph settings, 3D View/Cameras View Filters settings and the last opened folder paths).

To save or change the window layout, on the right of the menu bar, click **View Settings** and select the required option.



Custom layouts are saved by default to:

C:\Users\Public\Documents\Vicon\Tracker4.x\userName*Views*

> **Note**
> Loading a view file also loads the graph settings stored in that view file, replacing whatever graph settings you have configured in your current view.

Search for properties in the Processing panel

The Processing panel is not displayed in the Tracker default layout. To display it:

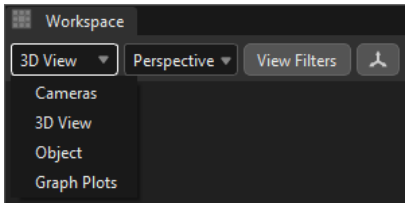
- From the **View** menu, select **Processing**.

The **Processing** panel provides a search facility and other controls that determine the visibility of the component properties.

To use the search, in the **Search filter** field at the top of the panel, enter the first few letters of the property you want to find.

Viewing system data

Vicon Tracker enables you to view system data in a number of different ways, depending on your selection in the **System** panel and the **Workspace**.

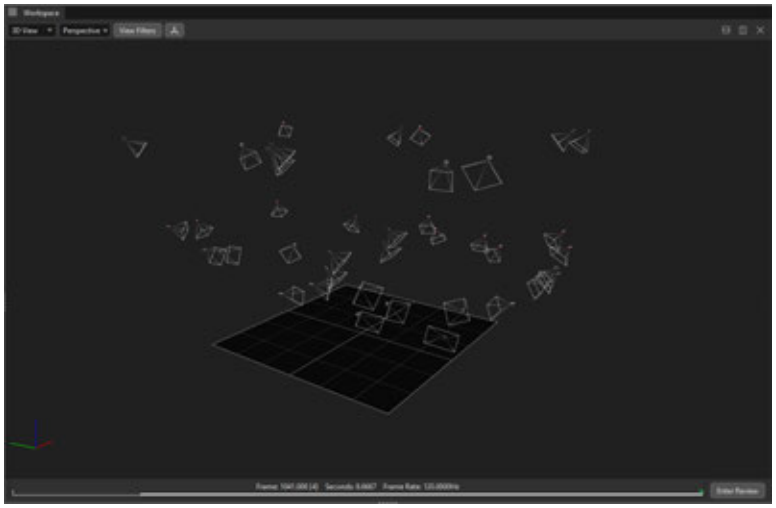


For information on viewing system data, see the following topics:

- About the Workspace on page 35
- About 3D View on page 40
- About the Cameras view on page 43
- About the Graph Plots view on page 47

For information on the **Object** view, see Workspace components on page 36.

About the Workspace



In the Workspace, you can change the type of data that is displayed, as well as the way in which the view is split, enabling you to view different types of data simultaneously. To save time, you can save and reload frequently used layouts.

By default, the **Workspace** is above the **Log** and to the right of the **System** panel. You can hide or display it by clearing or selecting the relevant option on the **View** menu. In addition, you can open a new floating workspace that can be displayed on a second monitor, if required. (To do this, select **View** > **Add Floating Workspace**).

Above the Workspace, on the right of the menu bar, the View Settings provide options for changing and managing the layout of the panels and Workspace, depending on your current task. These default layouts are supplied with Tracker:

- Camera Calibration
- Capture
- Default

Save the current layout

To save your current layout, including the panels and their location and sizing:

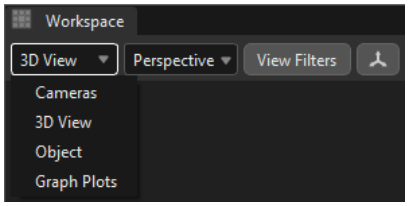
1. From the View Settings , select **Manage**.
2. In the **Manage View Settings** dialog box, click the Save button and provide a name for your new settings file.
   By default, your new file is saved with the *.View* extension to the folder *C:\Users\Public\Documents\Vicon\Tracker4.x*\UserName*Views*.
   When saved, its name is displayed in the **Manage View Settings** list.

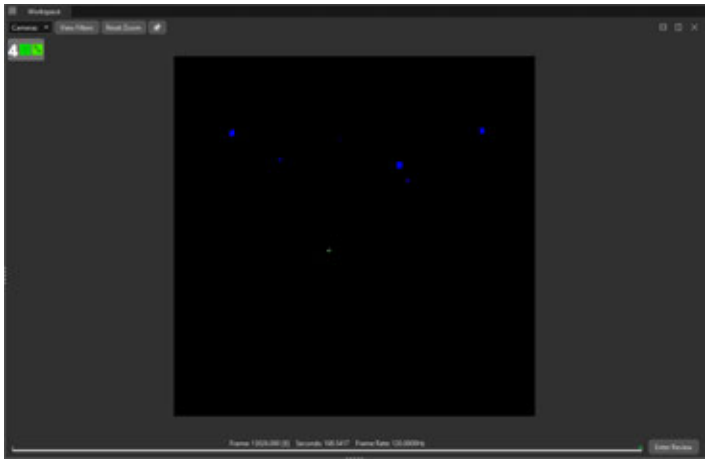
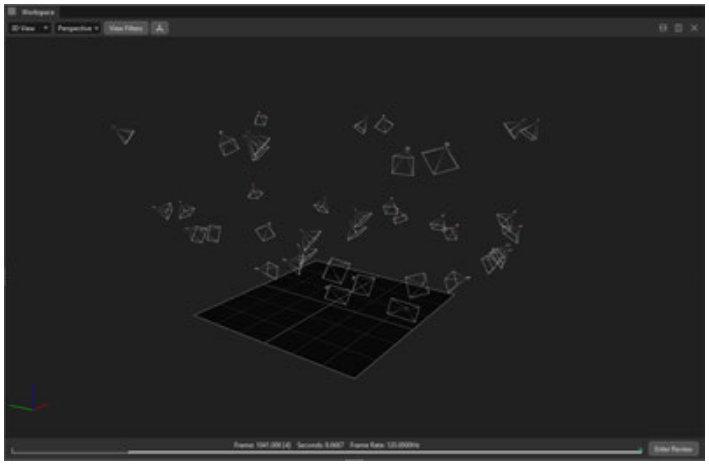
Note that in the **Manage View Settings** dialog box, you can also open saved layout settings or delete previously saved ones.

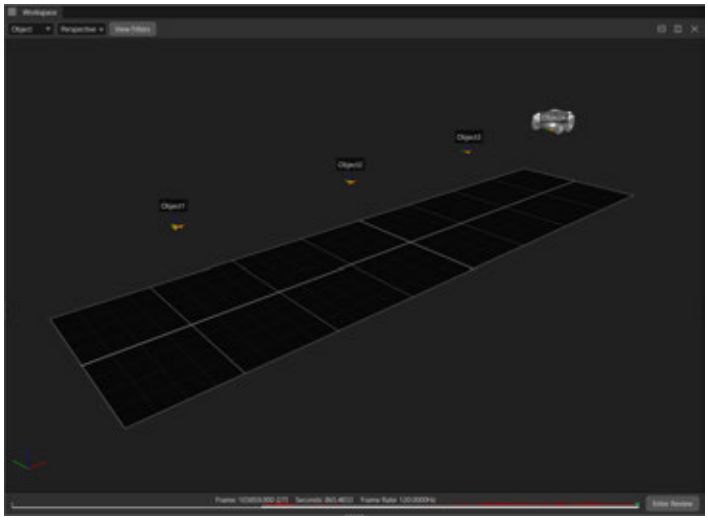
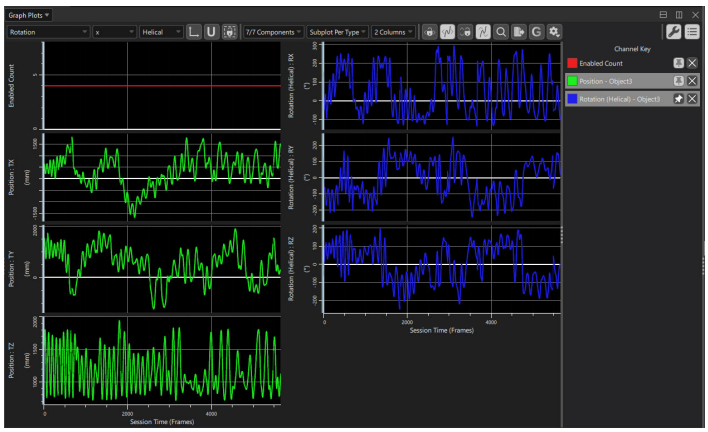
> **Tip**
> To revert to the default layout, on the right of the menu bar, click View Settings and select **Default**.

Workspace components

The view pane contains the following components:

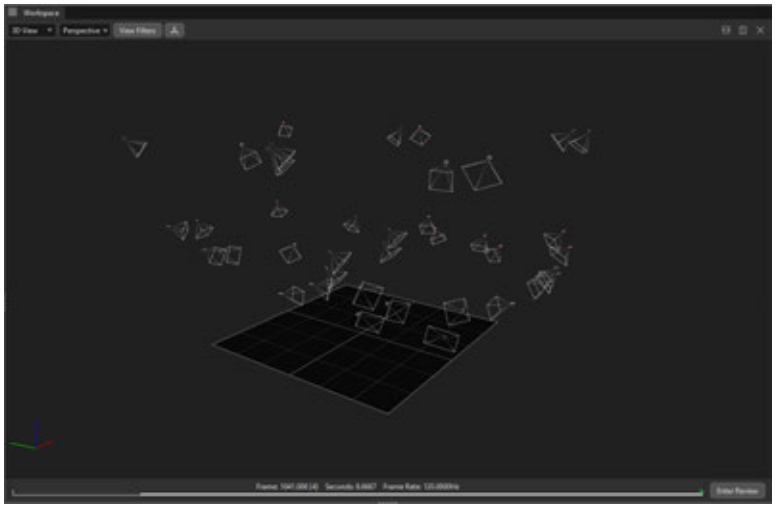
Component	Description
View pane list	The view pane list lets you configure the way in which you view Tracker data. Select from these types of view panes: 

Component	Description
View types	**Cameras** Displays raw 2D motion capture data from one or more Vicon cameras, depending on the current selection. 
	3D View Displays reconstructed motion capture data from all active Vicon cameras in 3D. 

Component	Description
	Object Displays all active objects in the Tracking panel with their local coordinate system relative to the Vicon global coordinate system. 
	Graph Plots Displays values of one or more selected items, such as the components of a marker trajectory, plotted against time. 
Split view buttons	By default, a single view pane is displayed in the workspace. Specify the number of panes using the following buttons:
	Horizontal  Split the current view horizontally into two view panes.

Component	Description	
	Vertical 	Split the current view vertically into two view panes.
	Close 	Close the current view pane. You cannot close the default view pane in the center of the Tracker window.
View pane time bar	Enables you to view the progress of the current capture, pause and play live captures, and play back captured data. In Review mode, to stop, start, move back or forward one frame, or to loop playback, click the relevant button at the right of the time bar. 	

About 3D View



The **3D View** displays the reconstructed motion data from all active Vicon cameras in 3D.

It contains the following components.

Component	Description
3D View pane controls	You manage the display of 3D data in the active workspace by selecting the following buttons: • **Perspective**, which can be Front, Back, Left, Right, Top or Bottom • **View Filters**, which enable you to select what is displayed in the view pane, and to select and create presets. For more information, see Set appropriate View Filters on page 29. • Object manipulator button, which enables you to work with objects. For more information, see Change an object's origin on page 181.
3D View pane	You view and manipulate 3D data in the Workspace. For example, the view can be oriented using the mouse and/or keyboard (see Mouse actions and keyboard shortcuts on page 70), so that you can focus on items of interest.

View data in 3D View

In **3D View**, you can observe reconstructed motion capture data from all active Vicon cameras.

When you have **3D View** displayed, you can:

- Highlight specific cameras in the 3D View by selecting one or more cameras in the **Vicon Cameras** list in the **System** panel.
- Generate a 3D overlay preview of each camera by double-clicking the camera body in the view. This overlay is inset into the 3D View and can be enlarged or closed within its window.
- Configure display options in the **View Filters**.

3D View hot keys

Use the following key combinations to work in the 3D View:

Action	Hot keys
Select multiple objects or markers	Hold CTRL + select markers
Select multiple objects or markers in an area	ALT+click and drag
Tracking view mode	ALT+right-click

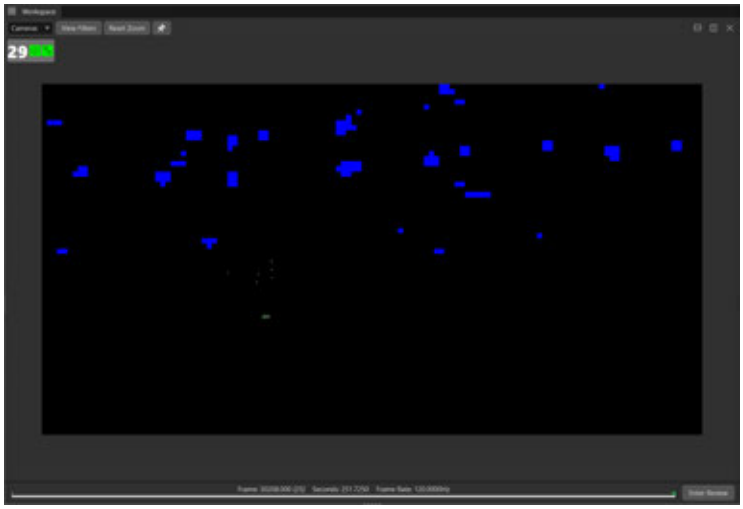
About the Perspective options

In the **3D View** and **Object** views, you can view motion capture data in 3D perspective from a specified point of sight, or direction, of the capture volume.

The **Perspective** view list contains the following components:

Component	Description
Perspective list	To change the perspective of the **3D View** or **Object** view, select from these options: • Perspective (the default view) • Front (ZX plane) • Back (XZ plane) • Left (ZY plane) • Right (YZ plane) • Top (XY plane) • Bottom (YX plane)
3D View or **Object** view pane	View and manipulate 3D data in the workspace.

About the Cameras view



The **Cameras** view displays raw 2D motion capture data from one or more Vicon cameras.

It contains the following components:

Component	Description
Cameras view	You view and manipulate 2D data in the Workspace. You can manage the visualization of camera data, for example, you can orbit, truck, dolly, and zoom the displayed data.
View Filters	Manage the way camera data is viewed in the **Cameras** view pane by clicking **View Filters** and selecting from the options. For more information, see Set appropriate View Filters on page 29.
Reset Zoom	Click to return the Cameras view to its default position and zoom.
Pin Cameras	Click to hold the current camera selection in the selected view. When enabled, selecting other system sources does not change this view.

Tip
To switch quickly between viewing a single camera and all cameras, double-click a camera view. If you are already viewing all cameras, double-clicking a camera view isolates the view to that specific camera.

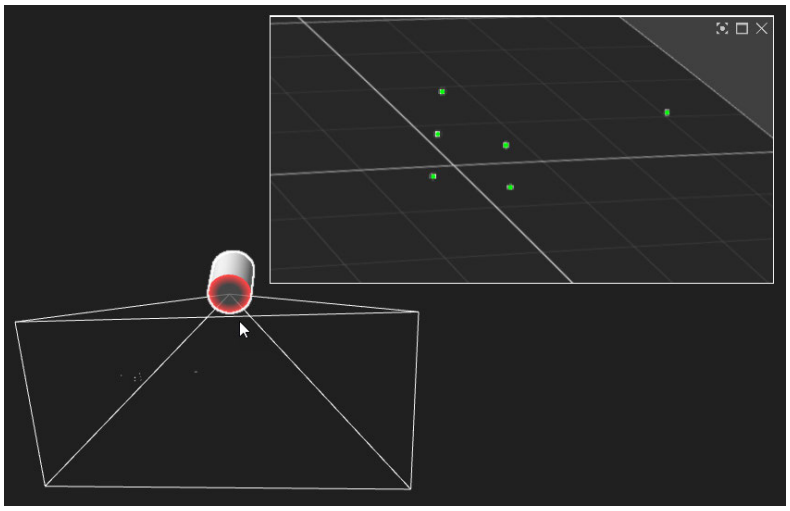
Understand camera performance indicators

Throughout Tracker, the color red is used as a warning of possible issues, the color green indicates good system health, while the colors between these extremes (orange, amber, yellow) indicate an interim state.

For example, the color of centroids that are displayed in the **Cameras** view indicates the current state of camera calibration:

- Centroids that are not connected are displayed in red in the **Cameras** views. This can be an indication that the relevant camera is not well calibrated.
- Centroids from uncalibrated cameras are displayed in gold.
- Centroids from calibrated cameras are green, indicating they are now contributing.

In a **3D View**, double-click on a camera's body to open its 3D overlay preview (see About 3D View on page 40) and zoom in on the markers. The color of the 2D centroids indicates how well this camera view is contributing to its reconstructions.



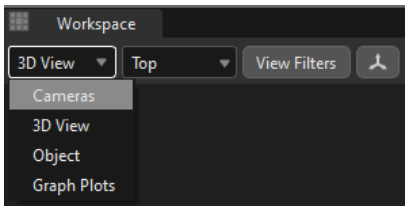
In the **System** panel, the camera icons give you an overall indication of the cameras' status.

Icon	Meaning
	Camera is active or connected (and calibrated)
	Camera is not calibrated
	Camera is (manually) disabled
	Camera is connected but not contributing data
	Camera is disconnected
	General warning symbol indicating an error

> **Note**
> If the option **Display Bump Notifications Per Camera** is selected in the **System Health** section of the Preferences (**Settings** menu > **Preferences**), you may also see the bumped camera icon  in the **Vicon Cameras** list.

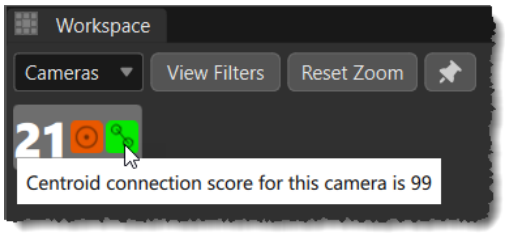
To display more information about the status of a camera:

1. In the **Workspace**, select the **Cameras** view.

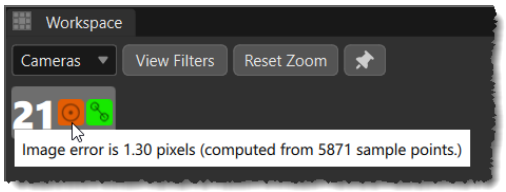


2. In the **System** panel, click a camera.
3. At the top of the **Cameras** view, hover the mouse pointer over the **Centroid connection score** icon  .

Information about the selected camera's centroid connection score is displayed.
Note that, as usual, the color of the icons at the top of the **Cameras** view provides an additional indication of the camera status.

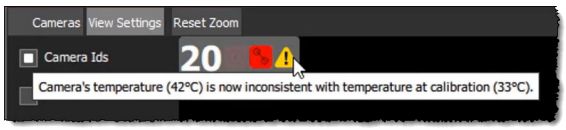


4. Hover the mouse pointer over the **Image Error** icon .
Information about the selected camera's image error is displayed.



This is similar to the image error that is displayed after camera calibration.

5. To investigate camera status further, hover the mouse pointer over any additional camera status icons to the left or right of the other two icons. These additional icons provide further information about the state of the camera: eg, a camera temperature warning.

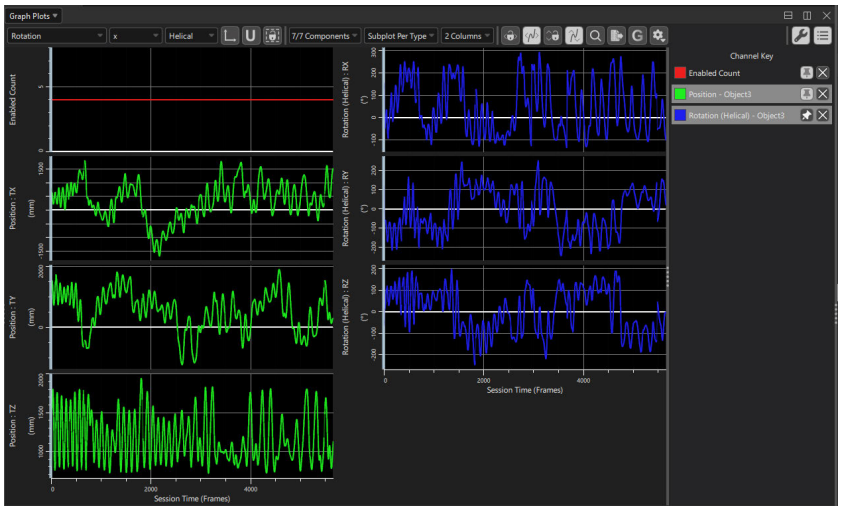


For information on the **Centroid Connection score** or **Image error**, see Monitor system health on page 149.

For information about how to handle bumped cameras, see Fix issues with camera calibration on page 155.
If one or more camera's operating temperature is inconsistent with its temperature at calibration, re-calibration is necessary (see Calibrating Vicon cameras on page 115).

About the Graph Plots view

In the Graph Plots view, you can view the values of one or more selected items (such as the x, y, and z components of a marker trajectory) against time.



Choose the data to view

To select a channel or channel source:

- In the **System** panel, click a device.

Or

- In the **Tracking** panel, click an object.

Or

- In the **3D View**, click an object or marker.

Traces are added to subplots based on the currently selected channel type.

To select all input channel sources:

- In the channel key on the right, click a channel entry.

All input channel sources are selected in **System** panel, **Tracking** panel or **3D View**.

For more information, see Graphing your data on page 202.

Set properties in Tracker

You can configure the way Tracker looks and behaves by configuring settings within:

- The menu bar (see About the menu bar on page 52)
- The preferences menu (see Preferences dialog box)
- Tracker panels (see Panel settings on page 49). The properties you can configure depend on the current selection.
- Workspace windows (see Workspace settings on page 51). The properties in a Workspace depend on the type of view that is displayed.

Most properties settings are automatically saved, so Tracker remembers them in subsequent sessions (see Tracker fundamentals on page 21). You can also save a specific set of properties settings using the System Settings menu  on the Tracker toolbar. System settings include all configurable properties in the app including settings for any devices connected to the system but does not include any object-specific properties as these are handled by its tracking configuration (Manage tracking configurations on page 187). Also, any changes to preferences (**Settings** > **Preferences**) and hot keys (**Settings** > **Show Hot Keys**) are saved in their own respective files.

As noted in Tracker fundamentals on page 21, remember that system settings files are only used to import saved settings and only the active settings files are always saved to the same files (eg, system files are saved to *AutoSave.system* and *LastRun.system*).

The following topics describe the general behavior of settings in a panel or Workspace and how to change them. For more information about specific properties in each panel, see Configuring your Vicon Tracker system on page 78.

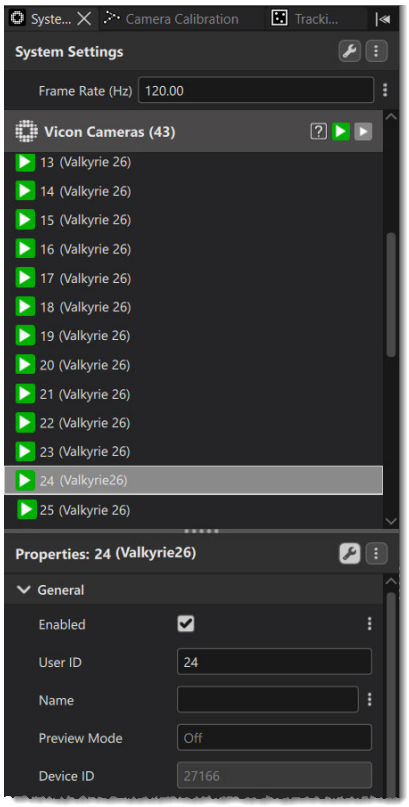
- Panel settings on page 49
- Workspace settings on page 51

Panel settings

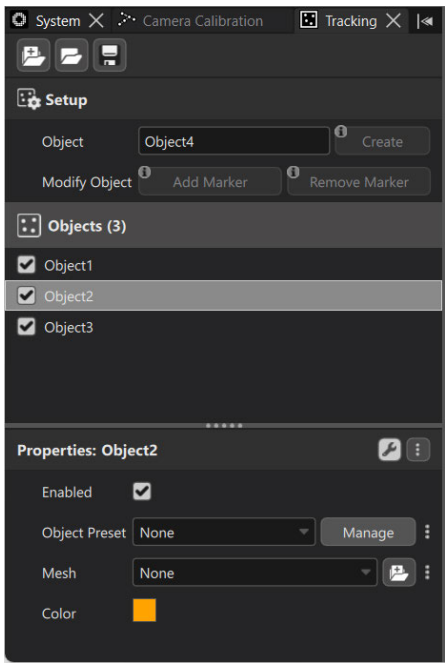
To configure settings in a Tracker panel:

1. Select the relevant panel or open the dialog box containing the properties you want to configure:

- For system components such as cameras and connectivity units, click the **System** panel, then click the required component and change its properties in the pane below.



- For tracking objects, on the **Tracking** panel, click the required object, click the **Properties** pane below and change the object's properties as required.



To save object-specific properties, make sure you save a tracking configuration (see manage tracking configurations on page 187).

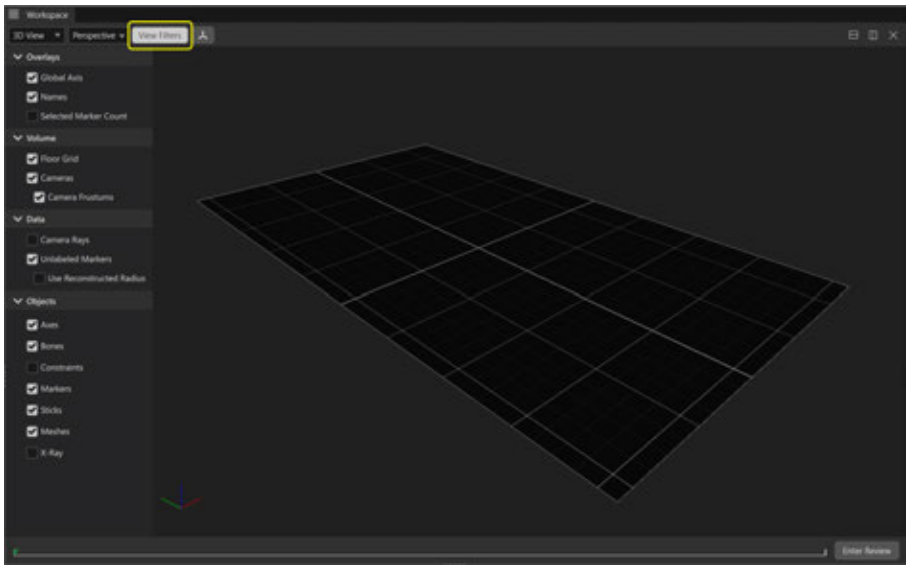
- To display only basic properties or to display all properties, select the Advanced Parameters toggle at the top right of the Properties pane.

- In the Properties pane, view or change the setting for the required property:
  - Select or clear a check box to switch the property on or off.
  - Click the current color in the entry field to display the **Set color** dialog box. In the **Basic colors** area, click the square for the required color, or in the **Custom colors** area, define a new color.
  - Click the drop-down arrow and select an entry from the list.
  - Move the slider to the left to decrease the value or to the right to increase the value displayed in the entry field.
  - Overtype the existing value.
- To return a setting to its default value, at the right of the relevant line in the panel, click the context menu button and select **Set to default**. To set all values in the panel to their defaults, click the Default Parameters button at the top right of the panel.

> **Tip**
> In the Processing panel, any parameter that has been changed from its default value is indicated by text in bold and italics.

Workspace settings

For view options, in the **Workspace** view pane, click **View Filters**. For more information, see Set appropriate view filters on page 29.



Graph Plots settings

For information on displaying the required data in a Graph Plots view, see Graphing your data on page 202.

About the menu bar

The Vicon Tracker menu bar contains these menus.

Menu	Options	Description
File	Exit	Closes the Tracker application window. If you have not saved any changes, Tracker displays a prompt to enable you to save changes before it closes.
Edit	Undo (Ctrl+Z)	Undoes the last action. This command is available only when using the object manipulator (see change an object's origin on page 181).
	Redo (Ctrl+Y)	Reinstates the previously undone action. This command is available only after an Undo command has been performed.
View	Add Floating Workspace	Opens a separate floating view pane.
	Camera Calibration	Displays or hides the **Camera Calibration** panel, which enables you to calibrate your Vicon cameras. For more information, see Calibrating Vicon cameras on page 115. Default: Selected
	Capture	Displays or hides the **Capture** panel, which enables you to specify the location and settings for data capture. This includes genlock and timecode information for the current session. For more information, see Capturing data on page 232. Default: Not selected
	Connections	Displays or hides the **Connections** panel, which displays currently connected clients. For more information, see Extending your use of Vicon Tracker on page 260. Default: Not selected
	Log	Displays or hides the **Log** in which you view the state of your Vicon Tracker system. For more information, see Monitoring system activity on page 252. Default: Selected

Menu	Options	Description
	Processing	Displays or hides the **Processing** panel, which enables you to change settings for object tracking, camera healing, performance tuning, reconstruction, and output. For more information, see Configure system processing parameters on page 109. Default: Not Selected
	Review	Displays or hides the **Review** panel, which displays all captures available to review. For more information, see Reviewing data on page 247.
	System	Displays or hides the **System** panel, in which you manage the components of your Vicon Tracker system. For more information, see Configure system settings on page 79. Default: Selected
	System Health Report	Displays or hides the **System Health Report** panel, which displays key metrics to evaluate the current health of the system. See System Health Report on page 164.
	Tracking	Displays or hides the **Tracking** panel, in which you view, create and manage objects. For more information, see Setting up object tracking on page 173.
	Workspace	Displays or hides the **Workspace** view panes. For more information, see Viewing system data on page 34.
Settings	Preferences (Shift+P)	Displays the **Preferences** dialog box, in which you can set default folder locations, specify default behavior for general options, set preferences for notifications and for object evaluation (see Understand object evaluation on page 193).
	Show Hotkeys (Shift+H)	Displays the **Hot Keys** dialog box, in which you can view, change and save Vicon Tracker hot keys, and load a saved hot key configuration. For more information, see Mouse actions and keyboard shortcuts on page 70.
	Control Authorizations	Displays the **Manage Control Authorizations** dialog box, in which you can revoke all stored Control authorizations (see also Use the Vicon Control app with Tracker on page 261).

Menu	Options	Description
Help	View Latest Help on docs.vicon.com	Opens the online Vicon Tracker Help system.
	View Installed Help	Opens a PDF of the *Vicon Tracker User Guide* that was installed with Tracker.
	Check for Updates	Checks the currently installed version of Tracker and enables you to update it if necessary.
	Check for Firmware Updates	Opens the **Firmware** dialog box, which lets you know if your firmware needs updating.
	Licensing	Opens the Vicon Product Licensing dialog box, which enables you to manage licenses. See License Vicon Tracker in *Installing and licensing Vicon Tracker*.
	Third Party Licenses	Displays required third-party license agreements and copyright notices.
	About Vicon Tracker	Displays the Vicon Tracker startup screen, in which you can view version information about the installed release of Tracker.

The Vicon Tracker menu bar also contains these controls and components:

System Settings list

 Enables you to view and select any saved settings files. The settings that are saved mainly control data capture or processing. The System Settings list also enables you to open the **Manage System Settings** dialog box, where you can import, save, and manage settings that you control in the **System** panel. For more information, see Configure system settings on page 79.

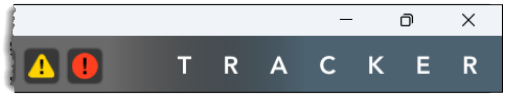
View Settings list

 Enables you to view and select the supplied **Default** tracking, **Capture** and **Camera Calibration** window layouts of the workspace and panels, and any saved customized layouts. Also enables you to open the **Manage View Settings** dialog box, where you can import, save, and manage view settings files. The settings that are saved are those affecting panel visibility, geometry and settings that only affect the Tracker UI (graph settings, **View Filters** settings for **3D View/Cameras**

view and the last opened folder paths). For more information, see Save your window layouts on page 32.

Windows power settings and firmware update icons

In addition to the menus and lists displayed on the Tracker menu bar, you may also see icons that alert you to the current status of your Windows power settings and/or Vicon firmware.



To display more information, hover the mouse pointer over the icon and, if required, click the icon to display additional dialog boxes.

See also Update system firmware on page 17 and Windows power options monitoring on page 15.

Indication of current system status

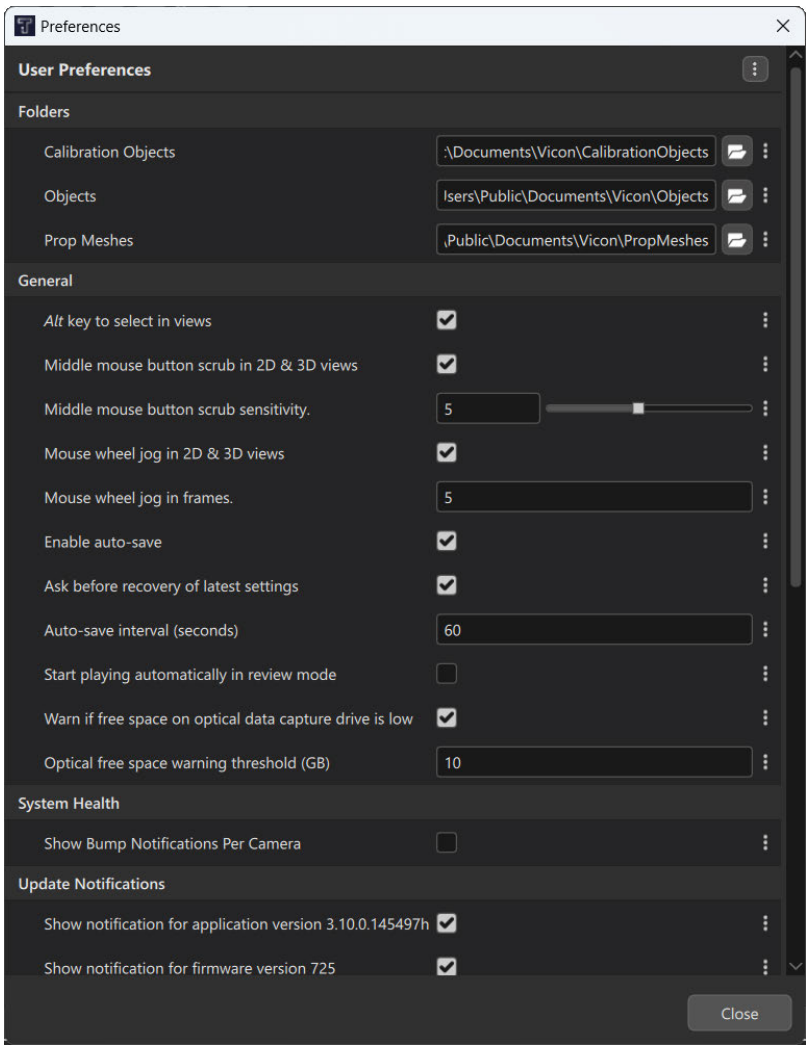
To remind you of the current mode, when Tracker is in the following states, the menu bar displays the appropriate descriptive text:

- Video preview
- Masking
- Calibration
- Review mode

Set user and system preferences

To control user and system preferences, you use the controls in the **Preferences** dialog box.

To access this dialog box, from the **Settings** menu select **Preferences** or press Shift+P.



For information on the two sections in the Preferences dialog box, see:

- User Preferences on page 58
- System Preferences on page 58

To configure settings in the Preferences dialog box:

1. Press Shift+P or from the **Settings** menu, select **Preferences**. The **Preferences** dialog box is displayed.
2. To view or change the settings for an option, click on the option to select it.

   > **Tip**
   > To see any available additional settings, click **Show Advanced**. To show basic settings only, click **Hide Advanced**.

3. Change the settings for each property, as needed.
4. Close the dialog box to implement the changes.

Changes made to preferences are tied primarily to your login and are automatically saved to the *C:\Users\Public\Documents\Vicon\Tracker4.x*\<userName> folder. Some preferences may also be found in *C:\Users\Public\Documents\Vicon\Tracker4.x*. All preferences files are updated when you successfully close the **Preferences** dialog box.

For detailed descriptions of all the settings in this dialog box, see Preferences options on page 59.

About User Preferences

At the top of the **User Preferences** section, in the Folders section, you can specify the location for calibration objects, objects and prop meshes. The default locations are:
C:\Users\Public\Documents\Vicon\CalibrationObjects, or *...\Objects*, or *...\PropMeshes*.

In the remaining sections, you can select or clear options for various features:

- **General:** Settings that control the functionality of certain keyboard and mouse actions as well as helping to manage autosave and disk-writing behavior
- **System Heath:** Options that allow you to control the visibility of system health related icons in the app
- **Update Notification:** Options concerning firmware notifications
- **Objects**: Options relating to object evaluation
- **Connections:** Options related to streaming data from Tracker
- **Channel Cache:** A text box that enables you to define the cache memory limit (MB)
- **Graph Plots:** Options relating to colors, rotation unwrapping, and showing an overlay to indicate the mouse origin and target

About System Preferences

In the **System Preferences** section, you can specify the path for Shared and User Data files. To change the current path, enter the location in the relevant data folder field or browse to it.

- For **Shared** folders, the default location is *C:\Users\Public\Documents*. With this default location, shared files are saved to subfolders in *C:\Users\Public\Documents\Vicon\Tracker4.x*.
- For **User** folders, the default location is *C:\Users\Public\Documents*. With this default location, user files are saved to subfolders in *C:\Users\Public\Documents\Vicon\Tracker4.x*\<userName>.

Preferences options

You can access all preferences via **Settings** menu > **Preferences**.

The Preferences dialog box is split into sections for user and system preferences.

- User Preferences on page 60
- System Preferences on page 65

User Preferences

In **User Preferences** you can view and/or change the settings in these subsections:

Folders section

Option	Description
Calibration Objects	Specifies where Tracker and other Vicon software saves all custom calibration objects. This does not include the standard calibration wand objects that can be found in *C:\Program Files\Vicon\Tracker4.0\CalibrationObjects* File types in this folder are *.vsk*. The default folder location is: *C:\Users\Public\Documents\Vicon\CalibrationObjects*
Objects	Specifies where Tracker saves all exported objects from the Tracking panel (see Work with objects on page 174) File types in this folder are *.vsk*. The default folder location is: *C:\Users\Public\Documents\Vicon\Objects*
Prop Meshes	Specifies the folder Tracker opens when you load a prop mesh. File types in this folder are *.fbx* The default folder location is: *C:\Users\Public\Documents\Vicon\PropMeshes*

General section

Option	Description
Alt key to select in views	When selected, holding the ALT key enables you to: • Draw a box with the left mouse button in 2D and 3D views to multi-select centroids, markers, or objects • Draw a box with the right mouse button in Graph Plots to zoom in on a range of data Default is enabled.
Middle mouse button scrub in 2D & 3D views	When selected, holding the middle mouse button and dragging left or right enables you to scrub backward and forward through review data. Default is enabled.
Middle mouse button scrub sensitivity	Controls the sensitivity of the cursor when used for scrubbing with the middle mouse button. Default is 5.
Mouse wheel jog in 2D & 3D views	When selected, enables you to use the mouse wheel to step through frames in Review mode.
Mouse wheel jog in frames	Controls the increment of frames progressed (forward or backward) when using the mouse wheel to scrub through review data. Default is 5.
Enable auto-save	When selected, this option enables the system to automatically save certain configuration files. For more details, see Tracker fundamentals on page 21. Default is enabled.
Ask before recovery of latest settings	When selected, if Tracker is re-launched from an unexpected shutdown, a pop-up asks which set of settings to use. For more details, see Tracker fundamentals on page 21. Default is enabled.
Auto-save interval	Controls the interval (in seconds) in which Tracker auto-saves its configuration files. Changing this setting has no effect if **Enable auto-save** is cleared. Default is 60 seconds.

Option	Description
Start playing automatically in review mode	When selected, captures loaded in review mode begin immediately upon loading. Default is disabled.
Warn if free space on optical data capture drive is low	When selected, Tracker warns you when your current drive is below its **Optical free space warning threshold**. Default is enabled.
Optical free space warning threshold	This option (in GB) controls when the free space warning is issued. If the **Warn** option is cleared, changing this setting has no effect. Default is 50 GB.

System Health section

Option	Description
Show Bump Notifications Per Camera	When selected, a notification is displayed for each bumped camera in the System panel and the Cameras view.

Update Notifications section

For features in this section to work, you must be connected to the Internet. If you're connected to the Internet, the version numbers automatically update; if you are offline, these version numbers may not be up-to-date.

Option	Description
Show notification for application version 3.10.0.145497h	When selected, Tracker notifies you if an updated version of Tracker is available. Default is enabled.
Show notification for firmware version 725	When selected, Tracker notifies you if your firmware is out-of-date. Default is enabled.

Objects section

Option	Description
Enable object evaluation	When selected, the system performs object evaluations in the background. For more information. see Understand object evaluation on page 193. Default is enabled.
Object evaluation step limit	Maximum number of steps to allow for evaluating each object pair. Increasing this value will provide more certainty that object similarities do not exist but will result in decreased performance. Changing this option has no effect if Enable object evaluation is disabled. Default is 1000.
Object evaluation uses tracking entrance threshold	This option controls which entrance threshold is used for object evaluation. If set to default (not enabled), the entrance threshold for object confusion evaluation is set to 1 and all markers are used to evaluate similarities between objects. If enabled, object confusion evaluation uses the entrance threshold specified in the Processing panel or the object preset, if one was set for an individual object. An entrance threshold less than 1 results in more object confusion warnings. Default is not enabled.
Object evaluation warning threshold (mm)	Threshold for differences between objects, expressed in mm. This warning indicates the object either closely matches another object or another view of itself (see Understand object evaluation on page 193). Changing this option has no effect if Enable object evaluation is disabled. Default is 3 mm.

Connections section

Option	Description
Control server alias	Enter the alias to be used in the Vicon Control app server list. If you leave this field blank, the PC host name is used.

Channel Cache section

Option	Description
Cache Memory Limit (MB)	This option sets the limit for the amount of channel data saved to memory before it is written to disk. **Note:** The path for channel data written to disk is configurable in the **System Preferences** section, in the **User Data Folder** field. Default is 512 MB.

Graph Plots section

Option	Description
Trace colors	This option controls the number of unique colors to be used for traces. You can choose between 9, 12, and 22 colors. The lower number of colors may assist those with limited color vision. Default is 22 colors.
Enable rotation unwrapping	When selected, angles are unwrapped when they exceed the typical (-π, π) radians range (see Graph Plots reference on page 227). Default is enabled.
Show pan/ scale overlay graphics	When selected, graphics (such as the dead zone) for zoom/pan/scale will appear in the window (see Change the scale of graphed data on page 216). Default is enabled.

System Preferences

The System Preferences section contains these fields:

Option	Description
Shared Data Folder	Enter or browse to the location of the folder in which you want to store data that can be shared between users. Default location is: *C:\Users\Public\Documents*
User Data Folder	Enter or browse to the location of the folder in which you want to store data that is to be stored per user. Default location is: *C:\Users\Public\Documents*

Vicon file types used in Tracker

During the motion capture workflow, you create a number of configuration files, Vicon Tracker generates a number of data files, and you can import files from and export files to other Vicon applications or supported third-party software.

You create and edit the following Vicon configuration file types during motion capture and analysis.

- Capture files on page 67
- Exportable configuration files on page 68
- Internal configuration files on page 69

Capture files

File type	Saved using configuration controls in	Description
.mcp	**Review** panel	Motion Capture file. Used for capture and contains processed time-series data for objects, devices and system performance derived from raw camera data and analog devices.
.x1d	**Capture** panel	Raw analog data
.x2d	**Capture** panel	Raw camera data

Exportable configuration files

File type	Saved using configuration controls in	Description
.system	Menu bar, **System Settings** menu	Tracker system settings
.View	Menu bar, **View Settings** menu	View options and layouts
.vsk	**Tracking** panel	Vicon skeleton file
.mcp	**Tracking** panel	Motion Capture file. Same file format as the .mcp capture file but when exported from the **Tracking** panel only contains object tracking information and does not contain any 6DOF data.
.xcp	**Camera Calibration** panel	Calibration parameters file. You can create, reset, and load an .xcp file but the .xcp file cannot be edited. You can export an .xcp created in Tracker to other Vicon application software and supported third-party software. For example, .xcp files are required if you wish to use Vicon Virtual System (https://docs.vicon.com/display/VVS/Vicon+Virtual+System+Documentation)
.graph	**Graph Plots** view	Graph Plots file. This file saves all currently pinned channels for future viewing. If a channel is unavailable, it may not be displayed even if it was previously pinned and saved within this file.
.HotKeys	**Hot Keys** menu	Saves all hotkeys. Can be imported to other users or machines.

Internal configuration files

File type	Saved using configuration controls in	Description
.Prefs	**Preferences** dialog box	Set default folder locations and select options for viewing data, mouse behavior, autosaving, etc, and for update notifications, object evaluation, data caching, and Graph Plots.
.json	**View**	Automatically saved from View Filters within the Workspace.

Mouse actions and keyboard shortcuts

This topic explains how to control Tracker with the mouse and keyboard.

Manage hot keys

To manage hot keys:

1. To display a list of all current hot keys, on the **Settings** menu, click **Show Hot Keys**, or press Shift+H.
2. In the **Hot Keys** dialog box, you can:
   - Save the hot keys that are currently listed (click the Save button at the bottom of the dialog box)
   - Load saved hot keys (click the Load button at the bottom of the dialog box)
   - Revert all the hot keys to their default settings (click the Default button  at the bottom of the dialog box)
   - Specify custom hot keys (in the **Command** column, find the required command and double-click in the **Key Sequence** column). For details, see Specify custom hot keys on page 71.

When you click Save, you can specify a file name and save the current hot keys as a **.HotKeys* file to:

C:\Users\Public\Documents\Vicon\Tracker4.x\username\HotKeys

If you import a *.HotKeys* file from another user or machine, make sure it is in this folder path so that you can select it in the Hot Keys configuration menu.

Specify custom hot keys

In the Hot Keys dialog box, you can specify custom hot keys for both current hot keys (ie, overwriting the default hot keys) and for commands listed in the Hot Keys dialog box where the Key Sequence column is blank (ie, for which there aren't currently specified key sequences).

To specify custom hot keys:

1. Open the **Hot Keys** dialog box (select **Settings** > **Show Hot Keys** or press SHIFT+H).
2. In the **Command** column, find the required command and double-click in the **Key Sequence** column.
3. Depending on whether you clicked a blank cell:
   - If you clicked on a blank cell (ie, a key sequence is not currently specified), with the **Set Hot Key** dialog box still open, press the sequence of keys you want to specify.
   - If you clicked on a current key sequence, in the Set Hot Key dialog box click Clear and then press the sequence of keys that are to replace the original sequence.

   You are warned if your custom key sequence will replace an existing key sequence.
4. If you want to save your custom hot keys, remember to click Save at the bottom of the dialog box.
5. Click OK.

Tracker hot keys and mouse actions

For mouse actions and keyboard shortcut for specific tasks, see the following tables:

- Control Tracker's appearance and behavior on page 72
- Move between frames on page 74
- Move the camera viewpoint on page 75
- Work in Graph Plots on page 76

> **Tip**
> To display a list of hot keys, select **Settings** > **Show Hot Keys** or press SHIFT+H.

Control Tracker's appearance and behavior

Use the following keys to control the way Tracker looks and behaves. Note that these are the default settings for these keys, which you can change in the Hot Keys dialog box.

Task	Keys
Camera Calibration view	2
Default view	1
Frame selected	F
Grayscale enabled in Workspace	G
Grayscale disabled in Workspace	Shift+G
Live/offline (toggle)	Space
Mask selected tiles in Workspace	E
Object manipulator (toggle)	M

Task	Keys
Preferences dialog box - display/close	Shift+P
Redo	CTRL+Y
Reset zoom	Z
Scale down manipulator	-
Scale up manipulator	+
Selected marker count overlay (toggle)	Y
Show hot keys	Shift+H
Track objects	X
Track selection	Shift+X
Tracking - clear	C
Tracking - lock to current selection	L
Undo	CTRL+Z
Unmask selected tiles in Workspace	R

Move between frames

Task	Keys
Go to frame	CTRL+G
Loop playback (toggle)	See Specify custom hot keys on page 71
Scrub to next frame	S
Scrub to previous frame	A
Scrub to first frame	See Specify custom hot keys on page 71
Scrub to last frame	See Specify custom hot keys on page 71
Start playback (forward)	See Specify custom hot keys on page 71
Start playback (reverse)	See Specify custom hot keys on page 71
Stop playback	See Specify custom hot keys on page 71

Move the camera viewpoint

Use the mouse and keyboard to move the camera viewpoint in 3D Perspective, 3D Orthogonal, and Camera view panes.

Task	Description	Mouse/Keyboard
Dolly/Zoom	Move camera viewpoint closer to or further away from the focal point	Right-click + drag forward or backward
Orbit	Move camera viewpoint around the focal point	Left-click + drag left, right, forward, or backward
Reset zoom	Resets the zoom of the selected camera views	Z
Truck/Translate	Move camera viewpoint along a horizontal or vertical axes	Click wheel button + drag left, right, forward, or backward

Work in Graph Plots

Task	Keys and mouse
Pin/unpin channels	Right-click on: • Subplot or axis, and select **Pin Channel**, then select the channel to pin or unpin. • Line in the **Channel Key**, and select **Pin All** or **Unpin All**.
Remove all channels from the subplot and the Channel Key	Right-click on a line in the **Channel Key**, and select **Remove All**.
Reset axis pan and zoom to default	Right-click on subplot or axis and select the required **Reset** option to reset either the X-axis, Y-axis, or both axes.
Switch between relative and session live time	When not in Review mode, right-click on subplot or x-axis and select or clear **Relative Time Display**. Default is selected. • **Relative Time** (the default) displays frame numbers relative to the latest system frame • **Session Time** displays frame numbers counting from the start of the current sync session (the current sync session number is indicated on the time bar in square brackets after the frame number). See Tracker fundamentals on page 21 for more information on a sync session.
Pan (slide) both x- and y-axis	Click middle button (or wheel, or both buttons) + drag on subplot
Pan (slide) axis only	Click middle button (or wheel, or both buttons) + drag on required axis
Zoom on both x- and y-axis	Right-click and drag (or CTRL+ wheel) on subplot
Zoom on single axis only	Right-click and drag (or CTRL+ wheel) on required axis

Task	Keys and mouse
Zoom to selection	ALT+right-click and drag on subplot (sets x- and y-axis ranges to fit a rectangle drawn with the mouse) To cancel, left-click.
Scroll subplot up/down	Rotate mouse wheel back or forward on subplot or axis
In Review mode, scrub one frame backward or forward	Press the A or S key

Configuring your Vicon Tracker system

You configure the hardware components of your Vicon Tracker system in the **System** panel. You can view and configure further system-wide settings in the **Processing** panel.

To configure your Vicon system:

When you first set up your Vicon system, ensure that the frame rate displayed at the top of the System panel is as required. If you need to change the frame rate:

1. At the top of the **System** panel, in the **Frame Rate** field, specify the required value (in Hz).
2. If you need to view or change settings for other system properties, ensure the Advanced properties are displayed and make any required changes.

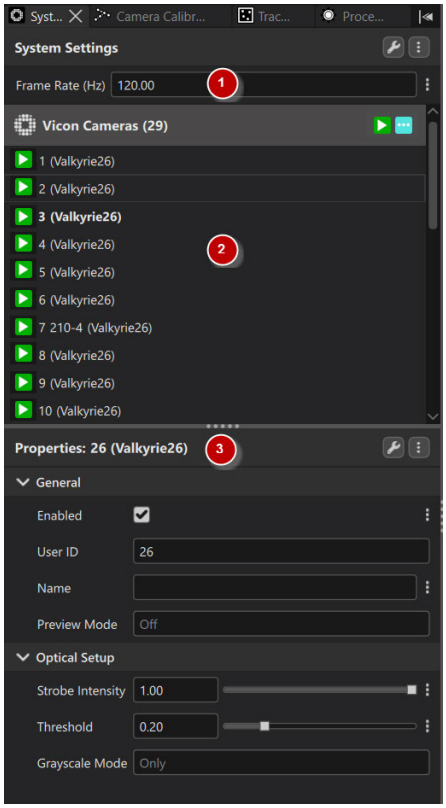
> Note
> Some properties are available only when advanced properties are displayed (at the top right of the Properties pane, click Advanced Parameters ).

For more information on setting up your Tracker system, see the following topics:

- Configure system settings on page 79
- Configure Vicon cameras on page 84
- Configure Vicon connectivity devices on page 99
- Configure analog devices on page 104
- Configure system processing parameters on page 109

Configure system settings

You configure settings relating to your Vicon Tracker system hardware in the **System** panel. It contains the following components:



Component	Description
1 System panel properties	Display or change the requested frame rate. To display other system settings, select Advanced Parameters (at the top right of the System panel).
2 System panel sections	Select the system component that you want to configure from the relevant section: • **Vicon Cameras** The identification and configuration settings for each Vicon camera connected to your Vicon system (see Configure Vicon cameras on page 84). • **Connectivity Devices** The identification and configuration settings for each Vicon Lock attached to your Vicon Tracker system (see Configure Vicon connectivity devices on page 99). • **Analog Devices** The identification and configuration settings for third-party analog capture sources, such as force plates, EMG equipment, and other generic devices (see Configure analog devices on page 104).
3 System component properties	View or modify properties of the selected system component(s) in the pane in the lower part of the System panel. The properties displayed depend upon the component(s) selected in the System panel sections.

To import, save, and manage System panel settings:

- Click the **System Settings** menu on the right of the Tracker menu bar to open the **Manage System Settings** dialog box.

To perform commands specific to a type of system component node:

- In the **System** panel, right-click the required component and select a command from the context menu.

System properties

At the top of the **System** panel, you can access the following system-wide settings. They affect all the connected cameras and devices:

Control	Description
Frame Rate	The requested rate (in Hz) at which to synchronize the Vicon cameras. Default: 120 Hz.
Genlock Setup	Choose to lock to an external genlock signal and to select a genlock standard. The type of video standard supported by the connected video source: None, PAL, NTSC, Film, 30Hz, VESA, SDI and SteamVR™ (to display the complete list, click in the **Genlock Setup** field). In the list, the icon to the left of each option provides additional information about the availability of that standard. **Note:** The 30Hz option enables you to run the Vicon system at multiples of 30 frames per second (above 50 fps), with timecode and genlock capability at true 30 fps, and works with Vicon Locks. Default: No genlock (ie, locking to an external genlock signal is not selected), None.
Timecode Setup	Choose to lock to an external timecode signal and to select a timecode source. Default: No timecode lock, None.
Genlock Offset	Specify a system offset relative to the genlock signal, as a fraction of the genlock frame period. For VESA modes, use the **VESA Offset** control. Default: 0.00
VESA Offset	Specify a system offset relative to the VESA signal, as a fraction of the VESA frame period. For non-VESA modes, use the **Genlock Offset** control. Default: 0.00

Control	Description
Preferred Sync Source	Enables you to choose the device (known as the sync source) that provides the overall synchronization signal to the system. You can select from these options: • Automatic Tracker automatically selects the sync source. • *DeviceName* One of the listed devices. You can set any device to be the preferred sync source, but if a connectivity device (Vicon Lock unit) is connected, it is always chosen as the sync source over a non-connectivity device. In the System panel, the entry for the device selected as the Vicon system sync source, is displayed in bold. Depending on your Vicon system and its connectivity devices, Tracker selects the sync source as follows: • If a Lock is included in the system, it is automatically selected as the sync source. • If the system does not contain a Lock, then a Vicon camera is automatically selected as the sync source. • If the system contains multiple connectivity devices, one of them is automatically selected as the sync source. However, you must ensure that the sync source is connected to the switch with the shortest network path to the host PC. Also note that genlock and timecode can only be provided by the sync source device. Because Tracker cannot detect which connectivity device is connected via the primary device to the PC, you may need to change the automatically selected source. Default: Automatic
Enable Tap-To-Select	Enable the Tap-to-Select feature of cameras that are equipped with accelerometers. Default: Selected
Enable Strobes	Enable the strobes on cameras. Default: Selected
Force Lowest Latency	When selected, forces Vicon cameras that offer this option into a mode that provides the lowest possible latency at the cost of reducing grayscale and centroid throughput. Generally, this mode is only useful when you're using low latency object tracking. Caution: In some systems with high numbers of cameras, selecting this option may cause network issues that are manifest as cameras appearing to drop out. Default: Selected

For information on the system components listed in the System panel, see Configure Vicon cameras on page 84, Configure Vicon connectivity devices on page 99, and Configure analog devices on page 104.

> **Note**
> The node for the device currently designated as the Vicon system synchronization source is displayed in bold in the **System** panel. See Preferred Sync Source on page 82.

Configure Vicon cameras

You manage the identification and configuration settings for each Vicon camera connected to your Vicon system in the **Vicon Cameras** section of the **System** panel.

Configuring Vicon cameras ensures that all the camera settings are correct and appropriate for your motion capture application. You can configure the settings for an individual camera, several cameras, or all cameras at once.

The **Vicon Cameras** section lists each Vicon camera connected to your system. For each camera, the node name includes:

- Its current status (the icons are the same as those used in the Cameras view, see About the Cameras view on page 43)
- The device User ID
- Any display name specified in the Name property
- The camera type listed in parentheses which follows after the User ID and Name, for example, **1 Over Door (Valkyrie26)**

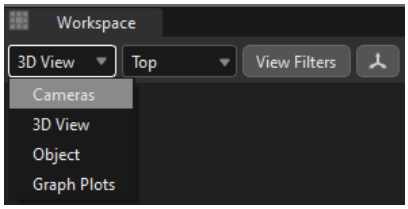
To configure your cameras for capture, complete the following steps:

- Configure Vicon cameras for optical data capture on page 85
- Prepare your volume for camera optimization on page 85
- Check camera focus on page 86
- Check camera aim and field of view on page 86

> **Note**
> By default, Tracker has Low Jitter enabled. This means that all cameras are set to send only grayscale data and no centroiding occurs on the camera. See Configure system processing parameters on page 109 for more information on Low Jitter.

Configure Vicon cameras for optical data capture

1. In the **Workspace**, select the **Cameras** view.



2. In the **System** panel, from the **Vicon Cameras** list, select the Vicon camera whose properties you want to configure. The 2D data being captured by each Vicon camera selected in the **System** list is shown in its own separate view pane.
   When you select a camera or set of cameras, the relevant properties are displayed in the pane below the Vicon Cameras list.
3. Make any changes necessary to the selected camera's properties. For information on how to adjust these settings correctly, see Camera properties on page 89.

> **Tip**
> To change the order of the cameras listed in the **System** panel, right-click a camera node and then click **Reorder Vicon Cameras**.
> In the **Reorder Vicon Cameras** dialog box, do either of the following:
>
> - Click and drag a camera node to its required location in the list.
> - Click a node and then click one of the buttons on the right to move it one position up or down the list, or to the start or end of the list.

Prepare your volume for camera optimization

1. Lay high-quality (ie, highly reflective) markers at the extremes of your intended capture volume.
2. Lay a similar set of markers in the middle of the volume.
   If your volume is very big, you may want to make a series of recognizable clusters of markers around your volume.
3. Make sure any unwanted reflections are removed.

Check camera focus

You can check the quality of the markers from the camera that you are focusing.

To check camera focus:

1. Ensure that the **Cameras** view is still selected.
2. Ensure that the desired camera is selected either on its own or as part of a group selection, and that you are looking at the correct camera view pane.
3. Try to identify some markers; pan and zoom in so you can see them clearly.
4. Adjust the settings on the camera lens:
   - On both the Valkyrie and Vero cameras, you may need to adjust both the aperture and its focus.
   - On Vantage cameras, only the apertures may need to be adjusted so long as the focus is set to infinity (except for small volumes).

   For more information on focusing, see the documentation for your Vicon cameras.
5. After completing the above steps, if your markers are still not well focused, consider making changes to the **Strobe Intensity**, **Threshold** or **Gain** properties.

> ⓘ Remember, you do not want to wash out your camera view, so set the aperture to ensure the camera view is not flooded with reflections.

Check camera aim and field of view

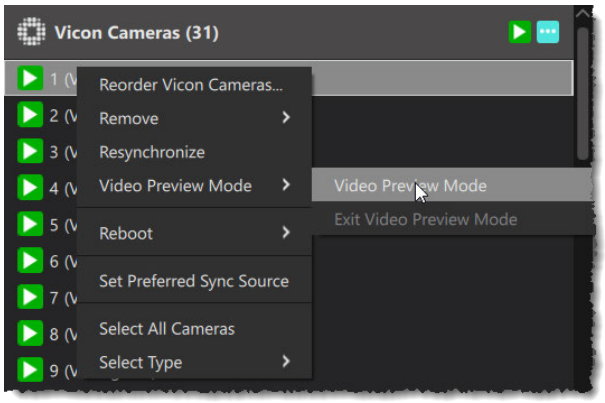
With the markers still scattered around the volume and the camera focused, check that the camera's aim and field of view are set appropriately. If not, use the pan/tilt head of the camera to adjust accordingly.

If you have difficulty orienting yourself in the Cameras view, you can check the aim and field of view of a camera in real time by switching the camera into Video Preview Mode. This mode displays a video image from the optical sensor of Vicon cameras that offer this option. All other camera views and parameters are inactive.

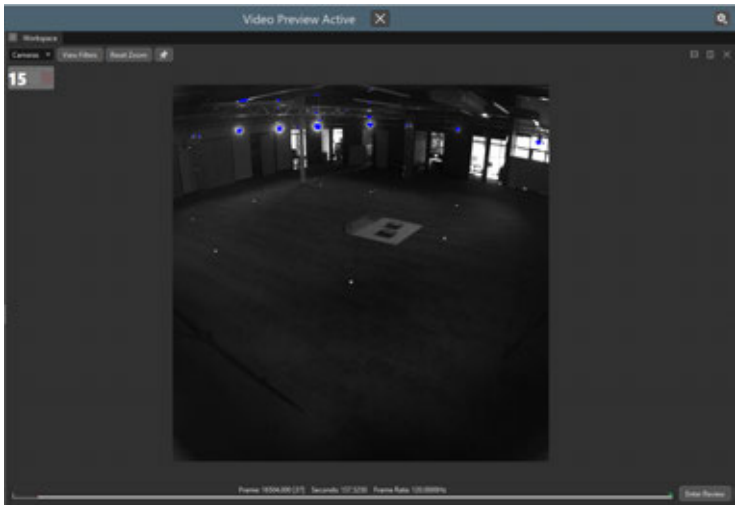
> **Note**
> Video Preview Mode is for system setup purposes only. You cannot use Video Preview Mode when you are calibrating, auto masking, capturing, or reviewing data.

To use Video Preview mode:

1. In the **Workspace**, select the **Cameras** view.
2. In the **System** panel, in the **Vicon Cameras** list, right-click a camera and select **Video Preview Mode** > **Video Preview Mode**.



All cameras change to Video Preview mode so they begin shipping video data. **Video Preview Active** is displayed in the menu bar:



While all cameras are in Video Preview mode, previews can only be viewed in one camera at a time. If you selected multiple cameras, only the last camera in the selection displays a preview.

3. To turn off Video Preview mode:
   - In the menu bar, click the X next to **Video Preview Active**.
     or
   - Right-click any camera in the list and select **Video Preview Mode** > **Exit Preview Mode**.

If the preview image is dark:

- At the top of the **System** panel, display the Advanced properties  and ensure that **Enable Strobes** is selected.
- Use external lights to illuminate your volume.
- Open the aperture.
  When you have finished checking the camera aim and field of view, be sure to set the aperture back to its original value.

All supported cameras can use Video Preview mode but their performance is dependent on frame rate:

- Valkyrie cameras support Video Preview mode from 30–900Hz. At frame rates above a Valkyrie camera's full frame rate (see Compare Range[7] towards the bottom of the Vicon Valkyrie web page), Video Preview mode uses windowing to display the same field of view as optical mode.
- Vantage and Vero cameras support Video Preview mode from 30–60Hz. At frame rates above this, an image may be displayed but this has not been tested. Vantage and Vero do not use windowing in Video Preview mode.

> **Tip**
> To optimize data quality and the camera's field of view, you are likely to iterate between checking the camera focus and its aim. This is particularly true for Valkyrie and Vero cameras; as you adjust the varifocal lens, you will need to both re-focus and re-aim.

7 https://www.vicon.com/hardware/cameras/valkyrie/

Camera properties

Depending on the cameras that are connected to your Vicon Tracker system, some or all of these properties are displayed in the lower part of the **System** panel when you click on **Vicon Cameras** or an individual camera.

> Note
> Some properties are available only when advanced properties are displayed (at the top right of the Properties pane, click Advanced Parameters).

General section

Control	Description
Enabled	The enabled state of the device Default: Selected
User ID	The customizable numeric ID of the device
Name	A user-defined display name for the entire set of Vicon cameras or for each individual Vicon camera.
Preview Mode	Displays the current state of Video Preview Mode (Previewing or Off). This parameter is read-only.
Device ID	The unique identification number Vicon assigns to each Vicon camera during manufacture.
Serial Number	The camera's serial number (if set).
Firmware Version	The version number of the Vicon firmware currently installed on the Vicon camera.
MAC Address	The Media Access Control (MAC) address assigned to the Vicon camera during manufacture. This is a hexadecimal value in the format ##.##.##.##.##.##.
IP Address	The Internet Protocol (IP) address assigned to the Vicon camera on the Vicon Ethernet network.
Enable Status Lights	When selected, the status lights on the Vicon camera provide feedback on the status of the camera.
Stream IP Address	Override the IP address to which data is sent.

Optical Setup section

Control	Description
Strobe Intensity (for cameras with strobes), or Optical Shutter Duration (for cameras without strobes)	For cameras with strobes, enables you to specify the duration that the camera's strobes are on and the shutter is open. For cameras without strobes, enables you to specify the duration that the shutter is open. Default: 1.00
Threshold	The minimum brightness (intensity) for markers; pixels of an intensity lower than this threshold are ignored. This value can be set between 0–1 to determine the pixels to be considered for centroid fitting onboard the Vicon cameras. Lower settings enable the camera to detect lower light levels, thus making the markers appear larger, but may pick up unwanted reflections and other light sources. Higher settings reduce the noise, but make the markers themselves less visible. This setting differentiates between markers and ambient light. A Vicon camera records 10-bit grayscale data, which for each sensor pixel is a measure of how much light fell on that pixel during a given amount of time. However, the cameras will almost always pick up some ambient light in the volume. To enable the cameras to distinguish between light that comes from markers and light that does not, a threshold is applied. Anything above this threshold is deemed to be a marker, anything below is deemed to be ambient light. A value in the region of 0.2 to 0.5 is usually appropriate, but Vicon strongly recommends that you use static markers in the volume in order to establish an appropriate setting. If cameras are evenly spaced around the volume, the same threshold value is usually sufficient for all cameras. Adjust this setting, the **Strobe Intensity**, and the camera's aperture until reflections are minimized or gone. Default: 0.20

Control	Description	
Grayscale Mode	The type of data that the Vicon cameras send to Vicon Tracker. By default **Low Jitter** is enabled so this setting will be read-only. The Vicon cameras can perform data processing to create 2D data for Vicon markers. They generate grayscale blobs for reflections from objects in the capture volume and then use centroid-fitting algorithms to determine which of these are likely to be markers by comparing the shape of the grayscale blobs to the **Circularity Threshold** and **Maximum Blob Height** settings. During this processing, Vicon cameras can produce the following types of data for grayscale blobs: centroids data (x, y coordinates and the radius of the centroid calculated), grayscale data (pixel and line information), or coordinates data (line information, that is, grayscale data without pixel values). Default: Only (read-only) You can specify which type of processed data Vicon cameras send to Tracker (ensure **Low Jitter** is disabled):	
	Auto	Send grayscale data only of the grayscale blobs for which centroids were not generated, that is, those below the threshold specified for **Circularity Threshold**. Send coordinates data of grayscale blobs for which one or more line segments, or the total number of lines in the blob, exceeds the value set for **Maximum Blob Height**. If a marker can be centroid fitted by the camera, the centroid is passed to the capture PC. If it cannot, the full grayscale of the image is sent, allowing the data to be post-processed on the PC. This is the default and recommended mode.
	None	Send no grayscale data; send only centroid data (i.e, x, y, and radius data). Any ambiguous grayscale data will be discarded.
	All	Send grayscale data both of grayscale blobs for which centroids were generated and of those for which centroids were not generated, that is those below the threshold specified for **Circularity Threshold**. Send coordinates data of grayscale blobs for which one or more line segments, or the total number of lines in the blob, exceeds the value set for **Maximum Blob Height**. Select this setting if you need to see exactly where the camera calculates the centroid with respect to the grayscale marker image, for example when adjusting parameters. This setting results in much larger data rates and files; it may be useful for diagnostic purposes, but do not use it in normal capture situations.

Control	Description	
	Only	Send all grayscale and coordinates data; send no centroid data. This setting is useful when focusing or making other adjustments to the cameras themselves as you see exactly the image recorded on the sensor. When **Low Jitter** mode is selected (its default setting) in the **Processing** panel, **Grayscale Mode** is locked to this setting.
	Edges	Send only edge coordinates data; send no centroid or grayscale data. If data rates are very high, for example when there are too many reflections, the camera automatically enters this mode. Use this setting to manually force the camera into this mode.
	No Edges	Send grayscale data both of grayscale blobs for which centroids were generated and of those for which centroids were not generated; send no coordinates data. Use this setting to prevent the Vicon camera from sending edge coordinates. **Caution**: Even if you have not specified a **Grayscale Mode** setting that would have coordinates data sent to Tracker, a Vicon camera automatically sends coordinates data – either temporarily or permanently – if it is overloaded with data (e.g., too many markers, too many reflections, hand or reflective objects immediately in front of the camera, too low a threshold or too high a gain). If a camera automatically starts to present coordinates data, identify the source of the overload and attempt to remedy it.
Sensor Mode	Tracker supports the use of the Vantage+ firmware upgrade, enabling you to use **High Speed** mode on your Vantage cameras without having to change the field of view (FOV) or lens. When you capture optical data, subsampling (selectively reducing the pixel count) enables you to run at high camera frame rates without reducing the FOV (frame size). In **High Speed** mode, you can run your Vantage cameras at higher frames rates while maintaining the FOV. You can change frame rates during capture and you do not need to set up your cameras again when you increase the frame rate, as the FOV is unchanged. Because the higher speeds are achieved through subsampling (removing some pixels from the frames), some reduction in resolution is incurred. For details, see Vicon Vantage camera performance comparison[8] in the *Vicon Vantage Reference Guide* . Default: **Default** mode	

8 https://docs.vicon.com/display/Vantage/Vicon+Vantage+camera+range#ViconVantagecamerarange-CameraComparisonViconVantagecameraperformancecomparison

Control	Description
Gain	The amplification of the pixel value. Select a displayed value to determine the intensity of the grayscale from the Vicon cameras: 1x, 2x, 4x, or 8x. (The available values are those supported by the camera.) This setting is applied to the camera to change the dynamic range of the recorded image. Increasing the **Gain** means that the marker has less variation in grayscale intensity between its center and its edge, but in certain circumstances, using a higher gain yields markers that are easier for the camera to distinguish. Adjust this setting if the markers appear too faint or if the cameras have trouble distinguishing them; otherwise, leave the this property at the default setting. Default: 1x

Centroid Fitting section

Control	Description
Maximum Blob Height	The maximum number of pixels per line that a grayscale blob can contain in a horizontal line. If the number of pixels exceeds this value, the Vicon camera determines that the grayscale blob is not a marker, stops processing it, and discards the pixel values (it preserves just the coordinates data, which can be sent to Tracker, depending on the **Grayscale Mode** setting). Set this value between 1–500 to determine how large a grayscale blob can be for a Vicon camera to consider it a candidate marker. The Vicon cameras consider grayscale blobs with horizontal lines containing this number or fewer pixels to be good-sized, circular marker images. The higher the value, the larger a grayscale blob can be; the lower the value, the smaller a grayscale blob must be. Default: 50
Circularity Threshold	The circularity threshold used by the centroid-fitting algorithms in a Vicon camera. With **Low Jitter** enabled by default, this setting will be read-only. To change, make sure you disable **Low Jitter**. This value can be set between 0–1 to determine how similar a grayscale blob must be to the internal model of a marker – that is a radially symmetric object that has smooth, sharp edges and whose pixel intensity is brightest at the center and gradually fades towards the edges. The Vicon cameras consider grayscale blobs with circularity equal to or greater than this threshold to be well-formed, circular marker images. The higher the value, the more stringent the centroid fitter is; the lower the value, the less stringent the centroid fitter is. You may want to apply higher settings for camera calibration to ensure that Tracker selects the best markers and thus provides the best possible calibration. Default: 0.50 (read-only)

Capture section

Control	Description
Process in Realtime	Enables you to choose whether the selected camera contributes to realtime reconstruction. Default: Selected

Temperature section

Control	Description
Camera Body, Sensor, Strobe Controller	The temperature reported by the relevant temperature sensor in degrees Celsius

Accelerometer section

Control	Description
Bump Sensitivity	Enables you to select the sensitivity of the camera's accelerometer for detecting bumps to the camera.

Display section

Control	Description
Enable Status Lights	When selected, the status lights on the Vicon camera provide feedback on the status of the camera. Default: Selected

Vicon Cameras context menu

When you right-click on a camera node in the **Vicon Cameras** list in the **System** panel, you can select from the following options on the context menu:

Option	Description
Reorder Vicon Cameras	Display the **Reorder Vicon Cameras** dialog box. This enables you to change the order in which Vicon cameras are displayed in the **Vicon Cameras** list.
Remove	Select from these options: • **Disconnected** - Removes cameras that have previously connected to the application session, but are no longer connected (eg, due to being unplugged).. • **Missing** - Removes cameras that have been loaded from a system or camera calibration file, but have not connected to the application. • **Selected** - Removes cameras that are currently selected.
Resynchronize	This setting resynchronizes all input types into Tracker.
Video Preview Mode	Select the required option to enter or exit Video Preview Mode. For more information, see Check camera aim and field of view on page 86.
Reboot	Select from these options: • System - Reboots all of the Vicon hardware devices in the Vicon system. Use this option if a camera has failed to boot, or if you need to reset the whole system for other reasons. • Selected - Reboots selected devices • Non-Contributing - Reboots non-contributing cameras. • Cameras - Stops and restarts all the Vicon cameras in the system. • Connectivity Devices • Clusters

Option	Description
Set Preferred Sync Source	If multiple connectivity devices are present in the system, enables you to select your primary connectivity device. Genlock and timecode can only be provided by a primary connectivity device. Default: Automatic If your system contains a Vicon Lock connectivity device, this is automatically selected as the sync source. For more information, see Preferred Sync Source on page 82.
Select All Cameras	Provides a quick way to select all cameras listed in the Vicon Cameras list
Select Type	Provides a quick way to select Vicon Cameras, Connectivity Devices, or Analog Devices

Configure Vicon connectivity devices

Depending on the type of Vicon system on which you are running Vicon Tracker, your Vicon system architecture will contain one or more Vicon Lock devices. Lock devices are connectivity units that facilitate the integration of synchronous third-party equipment with Vicon cameras by providing or receiving synchronization or timecode. Lock Lab also provides connectivity for third-party analog capture sources, such as force plates, EMG equipment, and generic devices.

When one or more Vicon connectivity device is connected to the Vicon Tracker system, the Connectivity Devices section is displayed in the System panel. The Connectivity Devices section lists each device of this type in your system.

To configure a Vicon connectivity device:

- In the **System** panel, go to the **Connectivity Devices** section and click the relevant connectivity device.
  The properties for the selected connectivity device are listed in the pane below.

For information on the properties you can configure for connectivity devices, see Connectivity device properties on page 100.

For more information on Vicon Lock devices, see:

- *Vicon Lock Lab Quick Start Guide* (PDF)
- *Vicon Lock Studio Quick Start Guide* (PDF)
- *Vicon Systems Setup Guide*

All are available from the Vicon documentation web site (docs.vicon.com[9]).

9 http://docs.vicon.com

Connectivity device properties

Depending on the connectivity devices that are connected to your Vicon Tracker system, some or all of these properties are displayed in the lower part of the **System** panel when you click on an individual device node (eg, a Vicon Lock) in the **Connectivity Devices** section.

- General section on page 100
- GPO Programs on page 101
- Display section on page 101

In addition to the following properties, you can also access related options from the Vicon Lock context menu on page 102.

> **Note**
> Except where noted, references to Vicon Lock, Lock devices, and Lock apply to all current models of the Vicon Lock (at the time of publication, this includes Lock Studio and Lock Lab).

General section

Control	Description
Enabled	Whether or not the connectivity device is currently enabled for use. Default: Selected
Sync Source	The Vicon Lock automatically becomes the source of synchronization for the Vicon system.
User ID	The customizable numeric ID of the device.
Name	A customizable display name for the connectivity device. Default: Blank
Device ID	The unique identification number Vicon assigns to each connectivity device during manufacture. Default: Identified on connection
Serial Number	The connectivity device's serial number (if set).

Control	Description
Firmware Version	The version number of the Vicon firmware currently installed.
MAC Address	The **Media Access Control** (MAC) address assigned to the device during manufacture. This is a hexadecimal value in the format ##.##.##.##.##.##.
IP Address	The **Internet Protocol** (IP) address assigned to the device on the Vicon Ethernet network.

GPO Programs

RCA sockets on the rear of the Vicon Lock Lab provide sync outputs to external third-party devices for synchronizing to the Vicon system.

These General Purpose Outputs (GPO) enable you to configure your system to trigger external equipment on or around each camera frame sync pulse. For more information, see 'Add synchronized output devices to a Vicon system' in the *Vicon Systems Setup Guide*.

Control	Description
Pins 1–8	The .gpo configuration file to use to specify the synchronization signal for Powered Sync Output 1–8 in the rear panel of the connectivity device. Default: Blank

Display section

Control	Description
Enable Status Lights	Enables you to select whether or not to use the status lights on the connectivity device that provide feedback on the status of the device.

Vicon Lock context menu

> **Note**
> Except where noted, references to Vicon Lock, Lock devices, and Lock apply to all current models of the Vicon Lock (at the time of publication, this includes Lock Studio and Lock Lab).

If a Vicon Lock is connected to your Vicon system, when you right-click on its node in the **Connectivity Devices** section of the **System** panel, you can select the following options from the context menu:

Option	Description
Reorder Connectivity Devices	Display the **Reorder Connectivity Devices** dialog box in which you can change the order in which Vicon Lock units are displayed in the **System** panel.
Remove	Choose between Disconnected, Missing, and Selected devices.
Resynchronize	This setting resynchronizes all input types into Tracker. This has the same functionality as the setting in the Vicon cameras context menu (Vicon Cameras context menu on page 97)
Reboot	Stop and restart the selected components. You can choose from System, Selected, Non-contributing, Cameras, Connectivity Devices, or Clusters.
Set Preferred Sync Source	If the system contains multiple connectivity devices, one of them is automatically selected as the sync source. However, you must ensure that the sync source is connected to the switch with the shortest network path to the host PC (known as the primary device). Also note that genlock and timecode can only be provided by the sync source device. Because Tracker cannot detect which connectivity device is connected via the primary device to the PC, you may need to change the automatically selected source. In the **System** panel, the entry for the device selected as the Vicon system sync source is displayed in bold.

Option	Description
Create Analog Device	Enables you to create an Analog Device node. For more information, see Configure analog devices on page 104.
Select All Cameras	Provides a quick way to select all the cameras listed in the Vicon Cameras list.
Select Type	Provides a quick way to select Vicon Cameras, Connectivity Devices, or Analog Devices

Configure analog devices

To set up an analog device for use with Vicon Tracker, you must have a Lock Lab connected as part of your system. If this is satisfied, you must set the required sample rate for the Lock Lab to which it is connected, create an analog device node, and then specify the required properties for the analog device.

- Set the sample rate on the Lock on page 104
- Create an analog device node on page 105
- Set up an analog device on page 105

Set the sample rate on the Lock

Vicon Lock Lab devices provide connectivity for third-party analog capture sources, such as force transducers, accelerometers, and other generic devices.

Each Vicon Lock device connected to your Vicon system is listed in the **Connectivity Devices** section of the **System** panel. Lock Lab has the following properties that are specific to its analog data, listed in the **Analog** section:

Property	Description
Sample Rate	Enables you to specify the rate (in Hz) at which analog data is sampled from the Lock. You can only set this to a multiple of the current system frame rate.
Analog Channels	Displays the number of channels of data (ie, pins) supplied by the Lock.
Analog Channels Available	Displays the number of channels available at the current sample rate. At higher sample rates, the higher-numbered pins on the Lock become unavailable. For more information, see 'Add analog capture devices to a Vicon system' in the *Vicon Systems Setup Guide*.

Create an analog device node

When analog devices are added to the Tracker system, they're listed in an **Analog Devices** section in the **System** panel.

To create an analog device node:

1. Ensure that the analog device is connected to your Vicon system through a Vicon Lock Lab (for an example system, see Tracker system architecture) on page 9.
2. In Tracker, go to the **System** panel, right-click the Lock Lab that the analog device is connected to, and select **Create Analog Device**.
   An **Analog Device** node appears beneath **Analog Devices**.
3. From the properties listed in the pane below, select the appropriate options for your device (see Set up an analog device on page 105 and Analog device properties on page 107).

Set up an analog device

The Analog Device node has a single output, but potentially multiple components. If your physical device has multiple outputs, you can represent this by creating multiple analog devices in Tracker, one for each output.

As a minimum, to get data from the device:

1. In the **System** panel, ensure you have selected the node that represents your device (See Create an analog device node) on page 105.
2. In the **Configuration** section, set the **Device Component Count** appropriately.
3. Specify which channels (ie, the numbered pins on the back of the Lock) that the device is connected to by doing one of the following:
   - If the components are in order and plugged into sequential pins, click **Sampler Channel Range** and select the required pins.
     or
   - Set the channel for each component separately in its own section at the bottom of the device's properties.
     Note that a given channel can only be used by one component of one device.

   When you have specified the required channels, the Lock starts to sample data from the device at the selected sample rate (see Set the sample rate on

the Lock on page 104), and to send the data to the Vicon system.
You can view this data in Graph Plots, export it to CSV, and include it in captures.

By default, the data displayed corresponds to the raw voltages sampled by the Lock. You can calibrate this data to output values that are easier to interpret in the following ways:

- Use the **Zero Level** button to zero your device. When selected, this button uses the previous second of data to establish the zero level.
  or
- Ensure Advanced Parameters is selected  and manually enter the zero level for each component, as well as an accompanying scale factor that can optionally be used to transform the voltages into the quantity being measured by the device.

For more information, see Analog device properties on page 107.

Analog device properties

Depending on the analog devices that are connected to your Vicon Tracker system, some or all of these properties are displayed in the lower part of the System panel when you click on an analog device node.

> Note
> Some properties are available only when advanced properties are displayed (at the top right of the Properties pane, click Advanced Parameters).

General section

Property	Description
Enabled	Enable or disable the device. When cleared, no data is sampled by the Lock, and the device is unavailable for graphing or captures.
User ID	Supply a numerical identifier that is useful for sorting devices.
Name	Enter a name that can be used to identify the device in graphs.

Configuration section

Property	Description
Analog Sampler	If you have multiple Lock Labs connected to your system, you can click this field to change the Lock to which the device is connected.
Analog Sampler Slot	Select the number of the slot for the analog card that this device is connected to

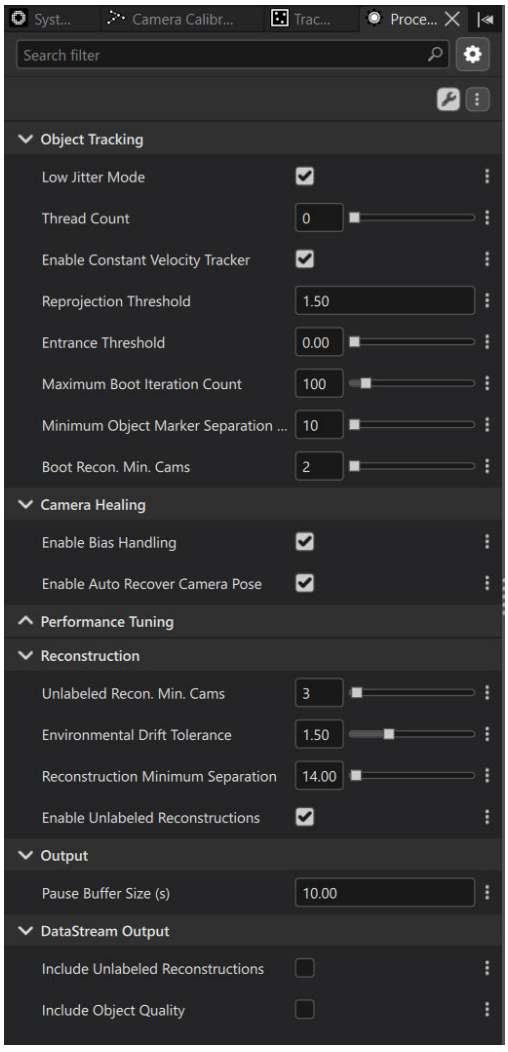
Property	Description
Device Component Count	Set the number of floating point components of data that are sampled from the device. Must correspond to the number of channels (pins) that the device is connected to on the Lock. For more information, see Set up an analog device on page 105.
Sampler Channel Range	Specify which pins the device is connected to on the Lock. For more information, see Set up an analog device on page 105.
Quantity	A list of quantities that you can optionally use to specify what the device is measuring. If you select one of these quantities, it is assumed that the device data is in SI units for that quantity, so you must also set the scale factor appropriately to transform the sampled voltages into these units. This unit is displayed in Graph Plots. For a free form label for each comjponent, use the component name.
Zero Level button	Automatically zeroes your device based on the last second's data. For more information, see Set up an analog device on page 105.

Component section

Property	Description
Name	Supply a name that can be used to identify this component of the device in graphs and in exported CSV files.
Input Channel	Specifies which pin the analog device is connected to, along with the gain to use on the pin (which determines the range of voltages that can be sampled from the device). Note that an analog device will not contribute unless each component has a unique, valid channel and that no two devices/components can share a channel.
Scale Factor	Can be used to rescale your device data to sensible units. For more information, see Set up an analog device on page 105.
Zero Level	Can be used to manually tweak the zero level voltage for each pin. For more information, see Set up an analog device on page 105.

Configure system processing parameters

In the **Processing** panel, you can modify settings which affect how Tracker processes object tracking and the type and/or amount of data it makes available for viewing or streaming.



For normal use cases, you're unlikely to need to change the settings in the Processing panel from their default values. For guidance on how to configure the Processing panel for specific applications (ie, high object count or high frame rates), see Understand object booting on page 191 or contact Vicon Support[10].

10 mailto:support@vicon.com

Any setting displayed in bold and italics has been changed from its default value. To return a setting to its default value, at the right of the relevant line in the panel, click the parameter context menu button and select **Set to default** . To set all values to their defaults, click the Default parameters button at the top right of the Processing panel.

- Object Tracking section on page 111
- Camera Healing section on page 112
- Performance Tuning section on page 113
- Reconstruction section on page 113
- Output section on page 114
- DataStream Output section on page 114

> Note
> Some properties are available only when advanced properties are displayed (at the top right of the Properties pane, click Advanced Parameters).

Object Tracking section

Tracker 4 uses two strategies for object identification: booting and tracking:

- Booting uses the 3D reconstructions along with the object's known dimensions to locate and fit an objects pose.
- Tracking uses the object's pose information from a previous frame.

In general, if the current frame can't identify an object, the next frame uses booting; if the current frame has the object, the next frame uses tracking.

Control	Description
Low Jitter Mode	Sets all cameras to pass grayscale data, allowing jitter reduction algorithms to work. For large systems this may cause system instability, due to network overload. Default: Enabled
Thread Count	Specify the number of threads to use. If zero (the default), the thread count is automatically calculated. Default: 0
Enable Constant Velocity Tracker	When selected, tracking for fast-moving objects is improved. However, it requires more computation so increases latency and decreases throughput. Default: Enabled
Reprojection Threshold	This threshold (in pixels) is used when forming correspondences between centroids and model points. If the camera calibration has drifted and correspondences are being missed then this value can be increased. This value is only used when Auto Bias Handling is disabled. Default: 1.5

Control	Description
Entrance Threshold	The minimum proportion of markers that must be visible to the system before the object is booted. If it is less than this value, the object is not booted. You can override this value for selected objects by using Object Presets (see Create an object preset on page 178). Default: 0.00 It is important to note: • Three markers must be visible before booting can occur. • The marker proportion always rounds to the next whole number (eg, if you want the entrance threshold to be for 6 of 7 markers, set the Entrance Threshold to 0.86).
Maximum Boot Iteration Count	The maximum number of iterations allowed for the booting algorithm. Increasing this parameter improves booting quality, but has a small performance cost. Default: 100
Minimum Object Marker Separation	The minimum distance allowed (in mm) between marker positions in order for them to be tracked separately. Default: 10
Boot Recon. Min. Cams	The minimum number of camera rays required to generate the reconstructions that are used for object booting. Default: 2

Camera Healing section

Control	Description
Enable Bias Handling	Computes and corrects for camera calibration bias. See Auto Bias Handling on page 158 for more details. Default: Enabled
Enable Auto Recover Camera Pose	Enables automatic recovery of bumped cameras. See Auto Recover Camera Pose on page 161 for more details. Default: Enabled

Performance Tuning section

Control	Description
Bias Handling State Throttle	Process every *n*th frame when computing the camera calibration bias. Default: 45
Live System Health State Throttle	Control how much processing is required for system health, by considering only every *n*th frame, eg, for a system frame rate of 100 Hz, set to 100 to process 1 frame every second. Default: 1

Reconstruction section

Control	Description
Unlabeled Recon. Min. Cams	Controls how many cameras (rays) must see the same marker (centroid) to create a new reconstruction. The minimum value that can create a reconstruction is two cameras. The maximum value of this parameter is 50 camera rays. If there are a large number of unlikely reconstructions being created, increase this value. The default value for this property is 3 (ie, three cameras), so if you are using a two-camera system, ensure you change the value to two before starting to work with Tracker. Default: 3
Environmental Drift Tolerance	An uncertainty applied (in mm) to camera calibration to take into account environmental factors such as temperature change, that may cause drift in the calibration. For larger volumes, increase this value; for smaller volumes, decrease this value. This setting applies for unlabeled reconstructions and when booting reconstructions. Default: 1.50

Control	Description
Reconstruction Minimum Separation	The minimum distance, specified as a value in the range 0–100 mm, allowed between 3D marker positions in order for them to be considered for reconstruction. If two candidate reconstructions are closer than this minimum separation, only the most likely reconstruction (in terms of the number of cameras contributing) will be reported. The other will be discarded. A higher value decreases the likelihood of creating spurious reconstructions, but increases the possibility that some genuine markers will not be reconstructed. To turn off this feature, set the value to 0.0. This setting applies for unlabeled reconstructions and when booting reconstructions. Default: 14.00
Enable Unlabeled Reconstructions	Enables generation of reconstructions using centroids that are not labeled as object markers. Enabling will allow you to create objects, add markers to an existing object, or align an object's orientation to a marker not associated with the object. If low latency is desired, this option should not be checked. Default: Enabled

Output section

Control	Description
Pause Buffer Size	The size (in seconds) of the output cache. For more information about the Pause Buffer, see Live Review on page 22. Default: 10.00 s

DataStream Output section

Control	Description
Include Unlabeled Reconstructions	Add unlabeled reconstructions to the datastream output. Default: Cleared
Include Object Quality	Add object quality to the datastream output. Default: Cleared

Calibrating Vicon cameras

During calibration, the Tracker camera calibration process calculates the physical position and orientation of each Vicon camera in the capture volume based on the movement of a calibration object (usually a Vicon Active Wand). The process describes the capture volume to the system, enabling Tracker to determine the physical positions, orientations, and lens properties of the Vicon cameras in the capture volume, and to correct for any lens distortion. Tracker uses this information to produce accurate 3D data.

As part of the calibration process, you can set the volume origin in Tracker. Tracker measures the position of the calibration object and uses this information to identify the origin of the world and its horizontal and vertical axes. These volume origin and axes are referred to as the global coordinate system. The global axes' coordinates are given in the form (x, y, z), where x is a horizontal axis, y is the horizontal axis perpendicular to x, and z is the vertical axis.

When a camera calibration process has completed, Vicon Tracker saves two identical calibration parameters (.xcp) files and two corresponding identical raw camera data (.x2d) files to a calibrations folder (*C:\ProgramData\Vicon\Calibrations*). The .xcp contains the calibration settings and threshold data specified for the Vicon cameras in your Tracker system and is used when data from these cameras is processed. The difference between the two .xcp and two .x2d files is in their naming convention within the calibrations folder and how they are automatically managed.

- LatestCalibration: These .xcp and .x2d files are replaced after each completed calibration process and are used for the current processing of camera data
- LatestCalibration yyyymmddnnnn: Up to 10 unique .xcp and .x2d files of this nomenclature are stored in the calibrations folder, with the oldest .xcp and .x2d getting written over by the latest calibration.

You specify settings for the calibration of Vicon cameras in the **Camera Calibration** panel.

> **Important**
> Calibration is a necessary process to enable accurate tracking. To understand the cadence at which you should perform a calibration, see Maintaining system health on page 147. When calibrating, you can perform the level of camera calibration that suits your requirements: a full camera calibration or a calibration of only a selected camera (for more information, see Calibrate a selected camera on page 130).

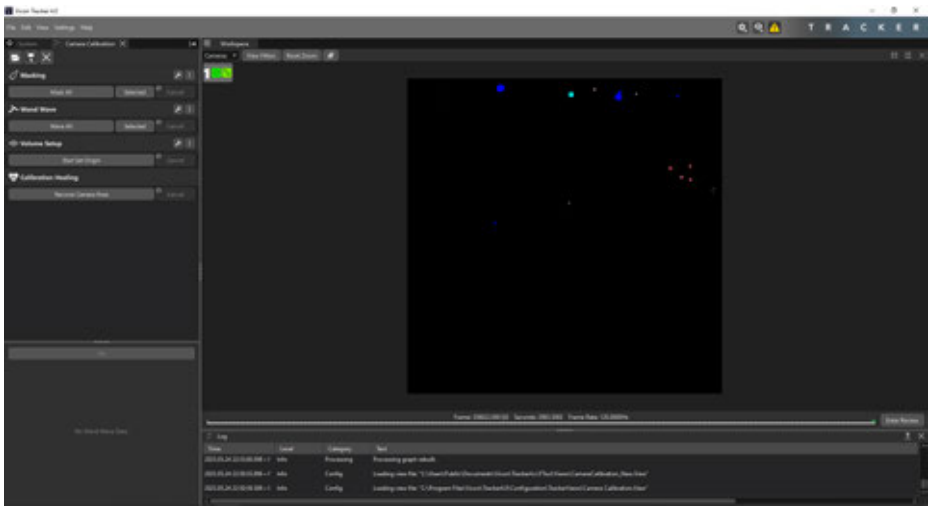
When you first connect up your Vicon system and start Vicon Tracker, notice that in the **System** panel and in the **Cameras** view, icons give you feedback on the current status of the cameras. The cyan icon indicates that although the cameras are connected, they are not yet calibrated. (For information on other icons that you may see in the Cameras view, see Understand camera performance indicators on page 44.

To calibrate your Vicon cameras, complete these procedures in the following order:

- Mask cameras on page 118
- Perform a wand wave on page 121
- Set up the volume on page 123

> **Important**
> Before you use your Vicon system to calibrate or track, ensure that cameras have fully warmed up to a stable operating temperature. For most cameras the warm-up time will be at least 30 minutes (a minimum 30–60 minute warm-up period is recommended) but for environments with lower ambient temperatures, it could take up to 90 minutes.
> To find out whether a camera has reached its steady-state temperature, use the Temperature section within the System Health Report. For more information on this, see System Health Report on page 164.

To help configure the UI to optimize the calibration process, consider using the Camera Calibration view type (see Customize the Tracker user interface on page 24). This will provide only the System and Camera Calibration panels while maximizing the workspace to display all the camera views.



For further information about camera calibration, see also:

- Calibrate a selected camera on page 130
- Camera calibration properties on page 132
- Camera calibration feedback on page 137
- Manage camera calibrations on page 138
- Scale calibration and set a fixed origin on page 139
- Maintaining system health on page 147 and Fix issues with camera calibration on page 155

Mask cameras

Before you begin calibrating, make sure that your camera views are clear of any unwanted reflections, whether they originate from markers or reflective materials in your lab. In either case, try to physically remove or cover the source of any reflections that are shown in each camera view as they can be mistaken for markers by the cameras. You can check the source of these reflections by using Video Preview Mode (see Configure Vicon cameras on page 84). If removing the source of the reflections is not possible, you must mask your cameras to remove the pixels caused by the reflections so that they don't influence the 3D data.

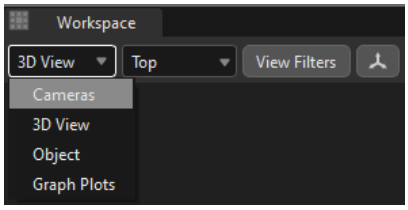
> **Tip**
> Physically removing unwanted reflections from your volume is preferable to masking, to ensure that you use all the pixels on your camera for 3D tracking.

If your camera view is not masked, you can see reflections represented by light pixels in the **Cameras** view. During masking, blue pixels are drawn in the **Cameras** view, enabling you to see how much of the view is masked.

> **Note**
> If your volume has windows or skylights, the natural light level will vary throughout the day, so reflections can be difficult to mask. Ideally, to prevent any natural light from entering the volume, cover any windows with curtains/blinds. If this is not possible, mask any windows and reflections in Tracker, either automatically (if it's sunny enough) or manually.

To automatically mask reflections:

1. Ensure you have removed from the capture volume any unnecessary objects, such as calibration objects, likely to cause background interference. Note that, to start masking, at least one camera must be contributing data.
2. In the **Workspace**, select the **Cameras** view.

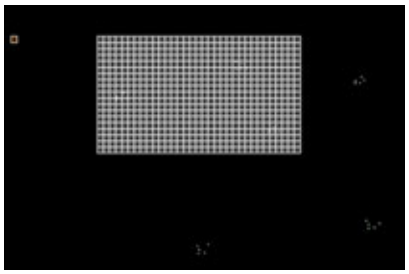


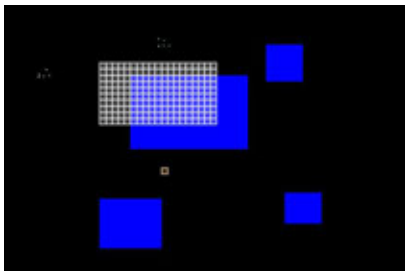
3. In the **System** panel, select all the cameras (SHIFT+click or drag or right-click and then click **Select All Cameras**).
   Alternatively, if you are already in the cameras view with a single camera selected, double-click within the camera view to display all cameras.
4. In the **Camera Calibration** panel, under **Masking**, click **Mask All**.
   The button displays **Stop** and at the top of the workspace, the menu bar changes color and **Auto Mask Active** is displayed.
   On the cameras, the status lights turn cyan while auto masking is in progress. Tracker starts tracking the data visible to each of the connected cameras. Any camera masks created are displayed as blue cells in the **Cameras** views for affected cameras. If no data is visible to a particular camera, Tracker does not create any masks for it.
5. Once all the light pixels in each camera have turned to blue, click **Stop**. The duration of this process depends on the number of cameras in your system.
6. In the **Cameras** view for each camera, ensure that any unwanted reflections are eliminated. (Each view must either be completely blank or contain some blue pixels.)

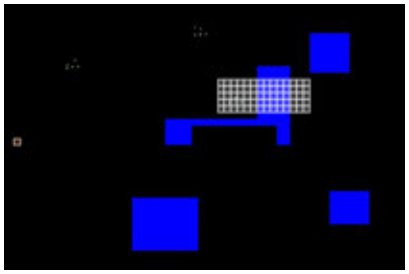
If the automatic camera masking that is described above does not eliminate all the unwanted reflections, you can manually remove any remaining reflections as follows.

To define camera masks manually:

1. In the **System** panel (**Vicon Cameras** list) or **3D View**, select a single camera.
2. In the **Camera Calibration** panel, go to the **Masking** section and ensure the advanced options are displayed (if necessary, click Advanced Parameters at the top right).
3. To begin editing the selected camera mask, click **Manual Mask Paint**.
4. In the **Cameras** view:
   - Alt+drag to select a mask area

     
   - Press E to add the current selection to the mask

     
   - Press R to remove the current selection

     
5. To apply the changes, click **Stop**.
   To revert to the original mask, click **Cancel**.

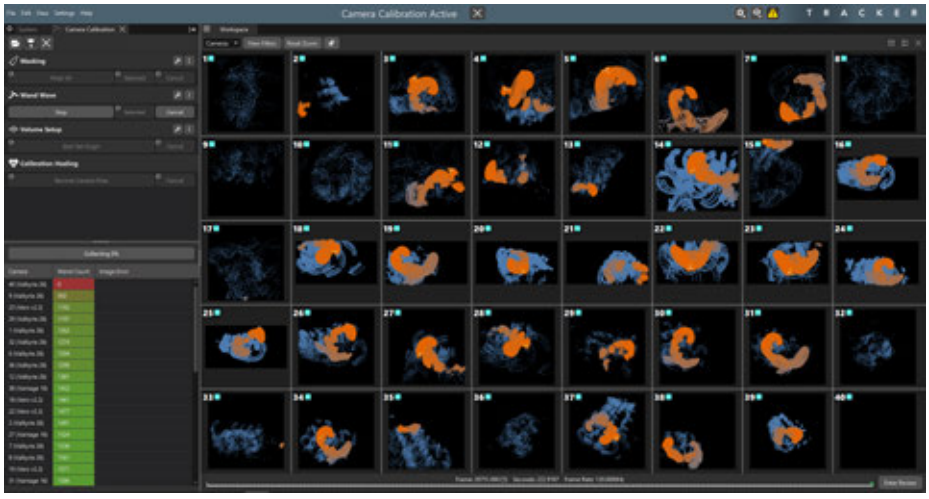
You can now wave the calibration wand throughout the volume (see Perform a wand wave on page 121).

Perform a wand wave

The main camera calibration process is achieved by waving the specified calibration device in the tracking volume. In general, try to wave the wand throughout the volume, ensuring that as many cameras as possible can see the wand at any one time.

To perform a wand wave:

1. Ensure you have completed the steps in Mask cameras on page 118.
2. In the **Camera Calibration** panel, in the **Wand Wave** section ensure the Advanced properties  are displayed and select the calibration object to use for the camera calibration process (by default, this is Active Wand v2).
3. Click **Wave All**.
   The button displays **Stop** and in the menu bar, the menu bar changes color and the text **Camera Calibration Active** is displayed.
4. Have someone wave the wand throughout the capture volume, covering depth as well as height, while you watch the **Cameras** views for all cameras to ensure you get full coverage. Ensure that the markers (LEDs) on the wand remain visible to all the cameras as much as possible while the wand is moved throughout the volume.
   As an indication of the age of the wand detection, to help you see where the wand is being waved and getting detections, the display in each view changes from orange to blue.

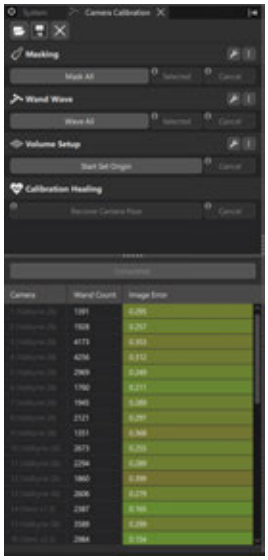


In the **Camera Calibration** panel, notice that the **Wand Count** column changes from red to green as sufficient data per camera is captured. The

camera order also changes so that the cameras that the cameras with the lowest wand count are moved to the top of the list. This feedback helps you concentrate on waving the wand for cameras that need more data.

> **Tip**
> By default, camera calibration stops automatically when each camera has seen enough of the wand to ensure calibration. To adjust this or turn it off, at the top right of the **Wand Wave** section, ensure Advanced properties is selected. To turn off the automatic stop, clear the **Auto Stop** check box. To adjust the amount of data needed before the camera calibration stops, change the value of **Auto Stop Minimum Frames**. Note that if you do this, the **Wand Count** column does not change color, and you will have to estimate when sufficient data has been captured.

5. After the wand wave has stopped, in the **Image Error** column, in addition to displaying the values, Tracker grades the status of each camera between red (poor) and green (excellent), depending on how well the camera can connect the centroids to the wand markers.



In the volume, the status lights on the Vicon cameras turn magenta and blink during calibration, becoming green and then blue when fully calibrated.

After the wand wave, the cameras are calibrated relative to each other but the volume origin has not been set. You can do this in the next step (see Set up the volume on page 123).

Set up the volume

After you have completed a wand wave (see Perform a wand wave on page 121), the next step is to set the volume origin on page 124.

Depending on your capture environment (for example, if your volume floor is not perfectly level), you may then need to set the floor plane. To further help with setting up your system, you may also want to set the floor extent and/or autonumber the cameras.

For further details, see:

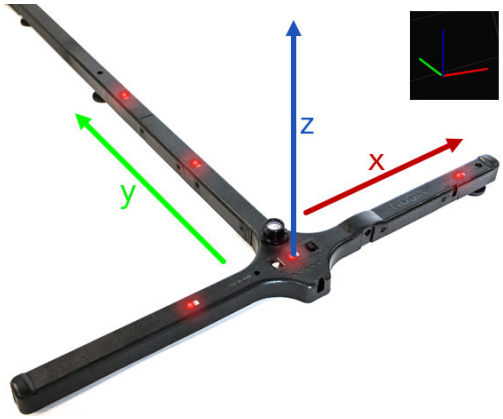
- Set the volume origin on page 124
- Set the floor plane on page 127
- Set the floor grid on page 129
- Autonumber cameras on page 129

Set the volume origin

After you have captured a wand wave, you set the volume origin and axes so the cameras and volume in Tracker reflect the actual positions of the cameras in relation in your defined coordinate system, as well as to each other.

1. To enable you to see the axes in relation to the volume, in the **Workspace**, change the view to **3D View**.

2. Place the calibration device on the volume floor in the position you want the volume origin to be and in the orientation you want the axes to be (reflected in the axes displayed in the **3D View**.



- X axis: red line
- Y axis: green line
- Z axis: blue line

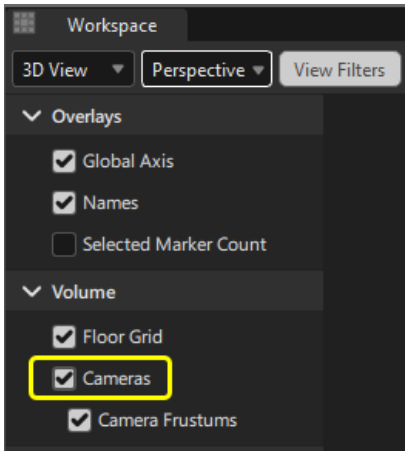
3. At the top of the **Camera Calibration** panel, to the right of **Wand Wave**, ensure Advanced Parameters is selected and in the wand list, ensure the appropriate Active Wand is selected (normally Active Wand v2).

   > **Tip**
   > Using a Vicon Active Wand enables you to set up your volume coordinate system quickly and easily. However, using a larger calibration object (for example, markers embedded in the volume floor and wall) can improve calibration stability and consistency over time, particularly in larger volumes. For more information, see Create a custom calibration object on page 188.

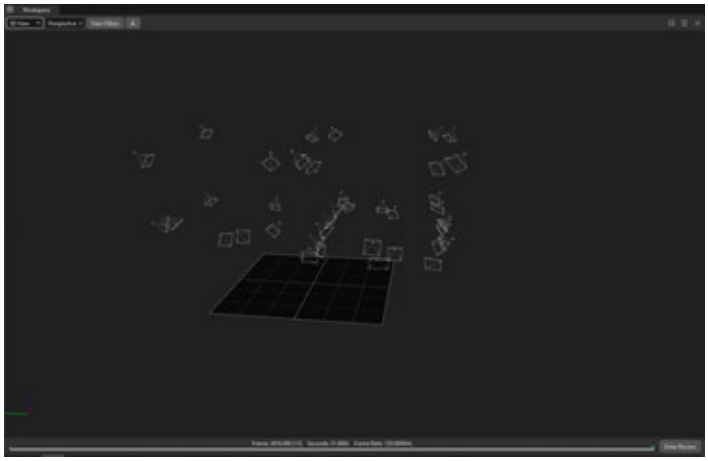
4. In the **Volume Setup** section, click **Start Set Origin**.
   The button displays **Set Origin** and is unavailable until Tracker has enough data to set the origin.
   If you need more information about why the button is unavailable, hover the mouse pointer over the button to view its tooltip. For more information, see About collecting frames on page 126.

5. Click **Set Origin**.

6. In the **3D View**, ensure that in the **View Filters** options, **Cameras** is selected.



In the 3D View, Perspective view, all of the cameras shift as a group, so the origin of the volume is aligned with the wand.



About collecting frames

If Tracker detects an issue with setting the origin, the tooltip for the Set Origin button displays the following information in the format 'Collecting frames (*reason origin can't be set*)' so that you can take the appropriate action:

Tooltip text (reason)	Action
L-Frame motion detected	Ensure the calibration object remains motionless while you are setting the origin.
No labeled data	Nothing is being tracked in the volume. If you are using an active wand, ensure the wand is switched on. If the wand LEDs are blinking, switch to Continuous mode.
L-Frame not tracked	The chosen calibration object was not detected. If you are using an active wand, ensure the wand is switched on. If the wand LEDs are blinking, switch to Continuous mode.
Multiple objects detected	Remove any extra objects that are being tracked in the volume.
Insufficient frames	The calibration object hasn't been tracked in enough frames yet. Check that the L-frame is being tracked consistently.

Set the floor plane

The final stage in calibrating your Vicon cameras is to set the floor plane, using markers in the volume to automatically define it. While this step is optional, it is recommended as it will help ensure the tracking floor plane aligns with the physical floor plane across the tracking volume.

The position of the virtual floor that is derived during origin setting process is extrapolated from the position of the wand in relation to floor of the volume. As the wand is a small object compared with the size of the volume, any slight discrepancy from the wand being level has a large effect over the rest of the volume when you set the origin. To account for any discrepancy, you set a floor plane, which takes a much larger area into account, so that the virtual floor lines up correctly with the actual floor plane.

To set the floor plane:

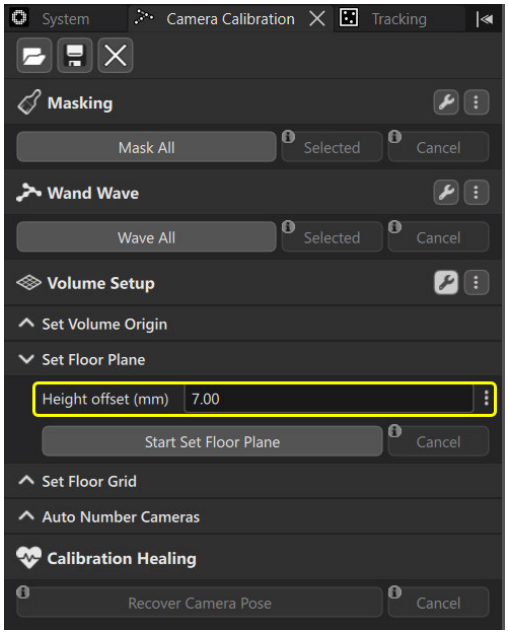
1. Ensure you have completed the rest of the camera calibration procedure and set the origin (see Set the volume origin on page 124).
2. Turn off the wand or remove it from the volume.
3. Scatter a quantity of the same size Vicon markers across the floor of your capture volume. If you want Tracker to automatically recognize these markers as floor plane markers, ensure that they outnumber any other groups of markers (e.g, markers on a wand or markers that were used to focus cameras, etc).
4. Check to make sure the **Height offset (mm)** parameter is specified correctly. If you need to change this value setting, see Adjust the Set Floor Plane settings on page 128.
5. In the **Camera Calibration** panel, ensure that to the right of **Volume Setup**, Advanced Parameters is selected, expand the **Set Floor Plane** section and then click **Start Set Floor Plane**.
   The button displays **Set Floor Plane**.
6. After a few seconds, click **Set Floor Plane**.
   In the **3D View**, ensure that in the **View Filters** options, **Cameras** is selected.

In the **Perspective** view, notice that the cameras shift as a group slightly along one or more rotation axes to better reflect an average of the markers scattered across the floor, taking into account any offsets that you specified.

Adjust the Set Floor Plane settings

When setting the floor plane, Tracker uses the center of all markers it has identified as being in the same plane. As the center of the marker is actually above the ground, you will need to specify an offset or else your floor plane (and Global Origin) may be higher than desired. To specify the proper offset, in the **Camera Calibration** panel, to the right of **Volume Setup**, ensure its Advanced Parameters are selected, expand the **Set Floor Plane** section and change the **Height offset** value to an appropriate value.

The **Height offset** is the amount (in mm) by which to adjust the floor plane (the default is 7 mm).



Tip
In general, to calculate the **Height offset**, add the radius of the markers to the thickness of the base of the marker. For a typical hard-based marker, this would give a Height offset of 9 mm (7 mm radius + 2 mm base thickness).

Set the floor grid

To more accurately visualize the dimensions of your volume in Tracker, you can change the size and shape of the floor grid.

To do this:

1. In the **Camera Calibration** panel, to the right of **Volume Setup**, ensure Advanced Parameters is selected.
2. Expand the **Set Floor Grid** section and change the values (in mm) to produce the required result.
3. Click **Set Floor Grid**.

Autonumber cameras

The **Auto Number Cameras** feature numbers the currently connected Vicon cameras in ascending order, according to their position in the volume. You may want to do this after you calibrate your Vicon system, so that your cameras are logically numbered before you begin tracking.

Automatic numbering starts with the camera that is furthest from the volume origin. The cameras are then numbered in a clockwise direction around the volume. If your cameras are positioned at different levels, the cameras in the level that contains the most cameras are numbered first.

To automatically number Vicon cameras:

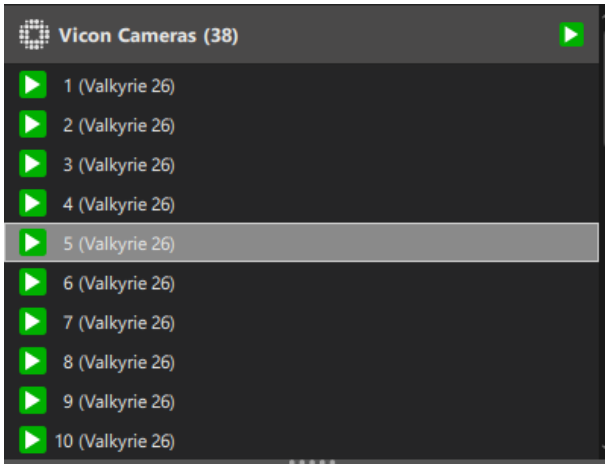
1. Ensure that the cameras are positioned as required, and that you have calibrated the cameras and set the volume origin.
2. To enable you to check the camera numbering for all cameras, in the **System** panel, ensure that you can see the list of Vicon cameras.
3. In the **Camera Calibration** panel, to the right of **Volume Setup**, ensure Advanced Parameters is selected, expand the **Auto Number Cameras** section, and click **Auto Number Cameras**.
   The cameras are automatically numbered in ascending order, according to their position in the volume.
4. In the volume, check that the cameras are now numbered as required by hovering your cursor over one of the cameras.

Calibrate a selected camera

In addition to performing a full system calibration (see Calibrating Vicon cameras on page 115), you can calibrate or re-calibrate a single camera or subset of cameras. This enables you to add cameras to your system, or move calibrated cameras, and calibrate with a shorter wand wave, saving the time it takes to perform a longer wand wave for all the cameras.

To calibrate a subset of cameras:

1. With the moved or additional camera(s) positioned in the volume, in the **System** panel, from the **Vicon Cameras** list, select the relevant camera(s). These cameras may be flagged as Uncalibrated ( ) if they are new.



2. In the **Camera Calibration** panel, in the **Masking** section, click **Selected**. The camera masking is updated to include the new or moved camera(s).
3. In the **System** panel, ensure the relevant camera(s) is/are still selected.

4. In the **Wand Wave** section:
   a. To ensure that only the wand wave for the selected camera(s) is/are required to meet the Auto Stop Minimum Frames value, make sure **Auto Stop** is selected.
   b. Click **Selected**.

5. In the volume, ensure that the person waving the wand does not stand too close to the new or moved camera(s), so that the wave can be captured by both the cameras of interest and the adjacent cameras.
   During calibration, the selected camera(s) is/are at the top of the Wand Count list until its wave is completed, when the list returns to the usual (device number) order.
   Calibration takes noticeably less time than the original full system calibration and the set origin step does not need to be completed.
   When calibration is complete, in the **Vicon Cameras** list in the **System** panel, the relevant camera(s) is/are flagged as connected and calibrated, with no other icons ( ).

Camera calibration properties

In the **Camera Calibration** panel, you can change the following properties:

- Masking section on page 133
- Wand Wave section on page 134
- Volume Setup section on page 135
- Calibration Healing section on page 136

> Note
> Some properties are available only when advanced properties are displayed (at the top right of the Properties pane, click Advanced Parameters).

Masking section

Control	Description
Slack	Specify the number of additional pixels to mask around the detected edges. Range 0 to 4. Default: 1 px
Clear Previous Masks	When selected, previous masks are cleared at the start of the masking process.Default: Selected
Mask All	Auto-mask all cameras
Selected	Auto-mask selected cameras
Cancel	Cancel the current auto-masking operation and restore the previous camera masks. For this button to be enabled, manual masking must be in progress.
Manual Mask Paint	Click to start manual masking. For this button to be enabled, at least one camera must be contributing data.
Cancel	Cancel the current masking operation and restore the previous camera masks. For this button to be enabled, manual masking must be in progress. This Cancel button is located next to the **Manual Mask Paint** button.

Wand Wave section

Control	Description
Wand list	Select the calibration object to be used during the camera calibration process. By default, the selected object is also used for setting the volume origin. If required, you can select a different object for setting the origin. To do this, ensure the Advanced properties are displayed and in the **Set Volume Origin** section, select the required object. Default: Active Wand v2
Auto Stop	When selected, Tracker automatically stops camera calibration when sufficient data (defined by the **Auto Stop Minimum Frames** parameter) has been collected. This is an advanced parameter. Default: Selected
Auto Stop Minimum Frames	With auto stop selected, the minimum wand coverage (in number of frames) required per camera before Tracker automatically stops calibration. Range 100 to 10,000. This is an advanced parameter. Default: 1000
Wand Ratio Tolerance	Tolerance of the distance between the markers on the wand (expressed as a ratio), to enable it to be labeled in 2D. Range 0.01 to 0.50. Default: 0.2
Wand Straightness Tolerance	Tolerance in alignment of wand markers (relating to the maximum angle allowed between markers) to enable it to be labeled in 2D. Range 0.01 to 0.50. Default: 0.2
Wave All	Start collecting wand wave data for camera calibration. At least two optical cameras must be contributing data.
Selected	Start collecting wand wave data for calibrating selected cameras. At least one camera must be selected for this button to be active.
Cancel	Cancel the current camera calibration operation.

Volume Setup section

Control	Description
Set Volume Origin section	
Synchronize L-Frame 	Click to control whether the L-Frame is synchronized with the wand wave calibration object. Disable to select a different L-Frame. Default: Synchronized
Perform Rescale	Rescales the calibration using the dimensions of the selected L-Frame object. For more information see Scale calibration and set a fixed origin.Default: Cleared
Start Set Origin	Click to start collecting data to set the volume origin. For this button to be enabled, at least two calibrated optical cameras must be contributing data.
Cancel	Cancel the current Set Origin operation. For this button to be enabled, Set Origin must be in progress.
Set Floor Plane section	
Height offset (mm)	Set the amount in millimeters by which to lower the floor plane. Default: 7 mm
Start Set Floor Plane	Click to start collecting data to set the floor plane. For this button to be enabled, at least two calibrated optical cameras must be contributing data.
Cancel	Cancel the current set floor plane operation. For this button to be enabled, Set Floor Plane must be in progress.
Set Floor Grid section	
Min X (mm)	Set the minimum x-coordinate of the floor plane in millimeters. Default: -3,000 mm
Max X (mm)	Set the maximum x-coordinate of the floor plane in millimeters. Default: 3,000 mm
Min Y (mm)	Set the minimum y-coordinate of the floor plane in millimeters. Default: -3,000 mm

Control	Description
Max Y (mm)	Set the maximum y-coordinate of the floor plane in millimeters. Default: 3,000 mm
Auto Number Cameras section	
Auto Number Cameras	Click to automatically number the cameras (see Autonumber cameras on page 129).

Calibration Healing section

Control	Description
Start Recover Camera pose	Click to start collecting track data generated by moving markers to recover the position of the selected camera(s). You cannot recover the position of a non-contributing camera.
Cancel	Cancel the current Recover Camera Pose operation. For this button to be enabled, Recover Camera Pose must be in progress.

Camera calibration feedback

In the **Camera Calibration** panel, below the camera calibration properties, you can view the camera calibration processing and status information. It contains the following components:

Component	Description
Progress bar	This bar displays a percentage indicating the progress of the overall camera calibration process.
Camera	This column contains the device ID for each Vicon camera being calibrated.
Wand Count	For each Vicon camera, this value identifies the number of frames it has captured containing the calibration object. Initially, the entry for the number of wand frames is displayed in red; the entry turns green when Vicon Tracker has acquired enough wand data to calibrate that camera (by default 1000 frames). If **Auto Stop** is selected (the default), the calibration process stops when the Vicon camera with the lowest frame count reaches the number of frames specified in the **Auto Stop Minimum Frames** field in the **Wand Wave** section.
Image Error	This value (in RMS distance in camera pixels) indicates the accuracy of the 3D reconstruction of the markers. This value represents the difference between the 2D image of each marker on the camera sensor and the 3D reconstructions of those markers projected back to the camera's sensor. Acceptable values depend on factors such as camera type. the size of the capture volume, and the camera lens type.

To sort the columns, click the required column heading.

Manage camera calibrations

At the top of the **Camera Calibration** panel, the buttons enable you to load, save or clear camera calibrations in your Tracker system.

As noted in Calibrating Vicon cameras on page 115, the camera calibration files that are saved after a completed calibration are not permanent and can be overwritten. If you want to keep a calibration so that it is not removed from this folder, you must save it.

If you want to extract the *.xcp* from a motion capture file (*.mcp*), such as one from a captured review, you must load that review and save it.

Loading and saving calibrations can be useful for:

- Comparing calibration changes
- Streaming data through Vicon Virtual System (see the *Vicon Virtual System User Guide*[11])

To manage camera calibration files in Tracker:

- At the top of the **Camera Calibration** panel, click the required button:

Button	Description
Load	Displays the **Load Camera Calibration** dialog box, from which you can navigate to and select the required *.xcp* or *.mcp* file and click **Open**.
Save	Saves the current camera calibration.
Clear	Clears all camera calibration parameters and masks for the cameras. This enables you to recalibrate the system from a clean starting point.

11 https://docs.vicon.com/display/VVS/Vicon+Virtual+System+User+Guide

Scale calibration and set a fixed origin

After you've calibrated the system in the usual way, including setting the volume origin (see Calibrating Vicon cameras on page 115), for improved scaling across calibrations and a permanently fixed origin point, you can create a large custom calibration object from markers permanently placed across the volume. You can then use this calibration object, coupled with using the Perform Rescale option, for subsequent setting of the system origin. This improves calibration stability and consistency over time. Calibration scaling may be particularly useful for large volumes, if the standard Vicon wand does not provide sufficient accuracy when used as an L-Frame.

> **Note**
> If it is impractical to use permanently fixed markers in your volume, you can still benefit from following this procedure, but when you come to recalibrate, substitute a scaled wand object in place of the custom calibration object. Your results will not be as accurate as they would be with a large calibration object, but you will still benefit from the scaling involved. For details, see Step 2 of Recalibrate with the scaled wand and custom calibration object on page 145.

These topics explain how to do this:

Choose LEDs or markers for your custom calibration object

To create your custom calibration object, you can use either of the following:

- An asymmetrical pattern of LEDs (emitting 850 nm wavelength light)
  If you use LEDs to create your custom calibration object, ensure the LEDs are turned on only during setting the origin, and that they are turned off during the calibration wand wave and while the volume is in use.
  or
- Reflective markers
  If you use reflective markers to create your custom calibration object, remember that as passive markers are continually visible, you may need to cover them while the volume is in use.

Set up the custom calibration object

To initially set up the custom calibration object:

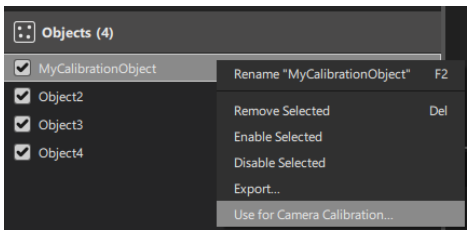
1. In the volume, place permanently static LEDs or markers to create a custom calibration object. Note the following points:
   - For best performance, **fix the LEDs or markers to the floor** (provides both stability and the ability to spread across the volume).
     If this is not possible, position them on a static wall or truss.
   - To guarantee a good measurement, locate the custom calibration object in an area of **good camera coverage**.
   - For best scaling performance, position the custom calibration object across the **central two-thirds of the volume** (to avoid variability introduced by gaps in coverage at the volume edges). If this is unfeasible, try to make the custom calibration object as large as possible, and position it towards the center of the volume.
2. As accurately as possible, measure the distances between points at two furthest edges of the object, and record the results. This can be a single measurement (eg, if the object's sides are equal), or two measurements across two different axes (eg, if the volume is not square).

> **Tip**
> For best results use a laser measure with a tolerance less than 1 mm.

Scale the Active Wand and the custom calibration object

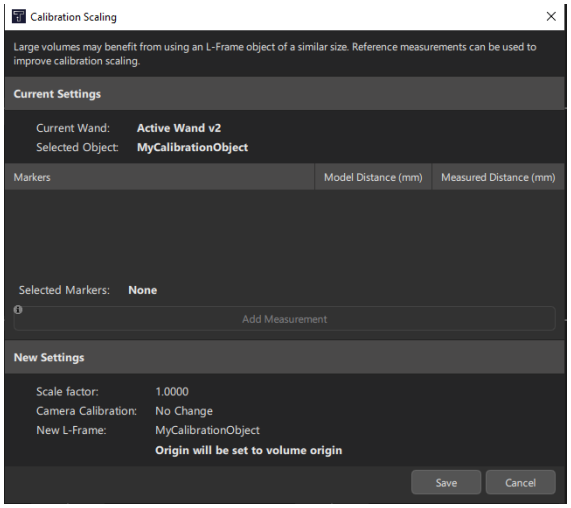
Each time you change the custom calibration object:

1. Calibrate using the normal process and standard *.vsk* files and set the origin using a standard calibration object (see Calibrating Vicon cameras on page 115).
2. In Tracker, create an object for the markers of the custom calibration object (for details, see Create objects on page 175).
   Do not save this object: it is important that the object that is used for this scaling is created from the current marker observations.
3. In the **Tracking** panel, ensure the custom calibration object is selected, right-click and then click **Use for Camera Calibration** .

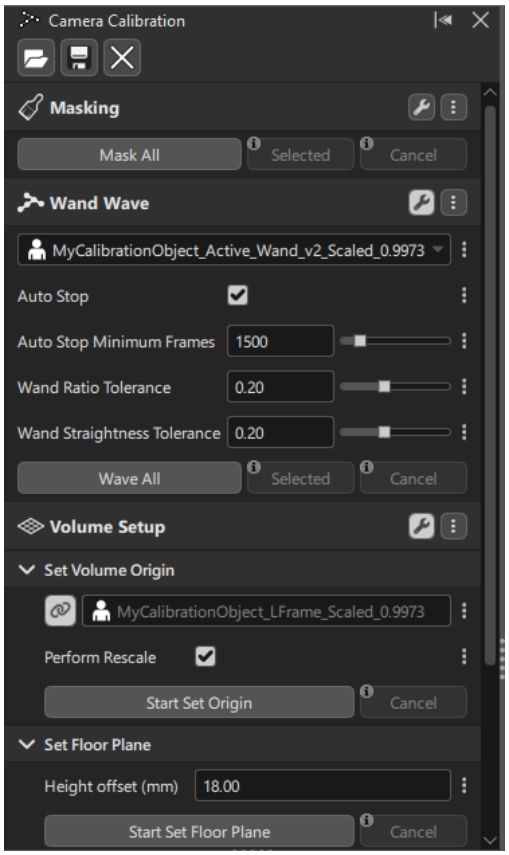


The **Calibration Scaling** dialog box is displayed and you are alerted that the origin of the selected object will be set to the global origin (0,0,0) when you click **Save**.

4. In the **Calibration Scaling** dialog box:
   a. In the **Current Settings** section, check that the **Current Wand** is the correct wand for your calibration, and that the **Selected Object** is also correct.
   b. Ensure the custom calibration object is enabled, then, in the 3D View or Object view, select a pair of markers that correspond to a measurement that you took earlier, and click **Add Measurement.**
   A line is added to the table containing the Model Distance, which is the distance between the markers as measured by the current Vicon calibration
   c. In the **Measured Distance** column, enter the distance that you measured in millimeters.
   d. For each set of measurements you have taken from the object, repeat steps b and c.
   In the **New Settings** section, the scale factor that will be applied is displayed, together with the output names for the scaled wand and calibration objects.



e. If you are happy with this measurement, click **Save** to exit the dialog box. A scaled wand and a calibration object file are saved by default to *C:\Users\Public\Documents\Vicon\CalibrationObjects* and are displayed in the Wand and L-Frame lists in the **Camera Calibration** panel.



The current calibration is also scaled by the same factor, so you do not need to recalibrate after this operation.

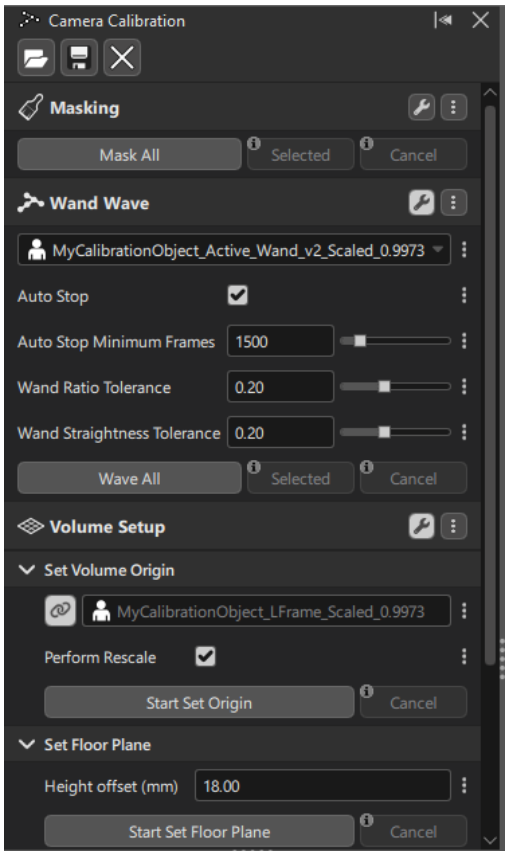
5. In future, to obtain an accurately scaled volume, use the new scaled wand and calibration object when performing the calibration and set object operations (see Recalibrate with the scaled wand and custom calibration object on page 145).

If you do not add measurements, the object is saved as a calibration object with no scaling modification, and no scaled wand is saved. You can still use the new calibration object for set origin operations, including rescaling. This will provide consistency of scale across set origin operations in different calibrations, but the volume will not be scaled to verified external measurements.

Recalibrate with the scaled wand and custom calibration object

1. Calibrate using the normal process, but in the **Wand** field, select the new scaled Active Wand *.vsk* file.

2. For the best results, set the origin using the normal process, but in **Volume Setup** > **Set Volume Origin**, ensure **Perform Rescale** is selected.



This ensures both a correctly scaled volume according to the measurements that you recorded of the custom calibration object; and also a permanently fixed origin, based on the static objects.

> **Tip**
> If you can't use permanently fixed objects in your volume, in Step 2 above, substitute the scaled wand object in place of the custom calibration object. Your results will not be as accurate as they would with the custom calibration object, but you will still benefit from the scaling of the wand.

3. Validate the new calibration by repeating the measurements from Step 5 of Scale the Active Wand and the custom calibration object on page 142.
   The measurements in Tracker should now closely align to the real world measurements of the fixed objects, as recorded in Step 2 of Set up the custom calibration object on page 141.

Maintaining system health

Optical motion capture relies on having a good quality estimate of the calibration for each of the cameras in the system. The calibration consists of both the pose (position and rotation) of the camera, and internal parameters such as the field of view, and those related to any radial lens distortion. We generally refer to the "camera calibration" as referring to that computed via the wand wave process, which is an estimation of the *true* camera calibration (i.e. the true poses and projection functions of the cameras).

To ensure a Vicon system has a good camera calibration (defined as one which is close to the true camera calibration), we have previously recommended performing calibration at regular intervals, for example, daily, based on observations of system performance. While this generally provides a good calibration, this strategy has the following disadvantages:

- The calibration may not have changed, which makes the recalibration redundant.
- The calibration may require additional attention between the regular calibrations.

Tracker now provides tools that enable you to reduce recalibrations and to ensure that some calibration issues are fixed or mitigated between recalibrations.

To achieve longer periods between complete recalibrations, you have to rely on a combination of:

- Camera calibration being stable
- Camera calibration monitoring plus manual fixing of any issues
- Camera calibration automatic healing

Tracker contains tools to both monitor the performance of the system, and in particular the health of the camera calibration, and to help mitigate camera calibration issues. Before exploring those tools, it is worth examining what is meant by calibration stability and the types of issues related to the calibration.

Types of camera calibration issues

Camera calibration issues can come in a variety of forms and have different causes. Some of the common issues are:

- Poor initial calibration
- Camera internal elements shifting as they reach operating temperature
- One or more cameras moved to a different location
- One or more cameras knocked and position or rotation changed
- One or more cameras' mounts slipping
- Rig expanding/contracting due to environmental temperature changes

Small, incremental changes in the camera calibration are referred to as "calibration drift" or "cameras drifting out of calibration".

You can use both automatic and manual tools to handle these issues without requiring a full recalibration.

Whether you are taking advantage of automatic healing tools, using the manual tools, or just want the system to indicate that it may be time for a full recalibration, it is important to understand the monitoring utilities that report issues related to camera calibration. To find out more, see Monitor system health on page 149.

Monitor system health

To monitor system health, first view the available information about the tracking, position and rotation of the tracked objects. For a more detailed examination of any possible issues, you can then use Tracker's main health metrics.

- Plot graphs of object count and object position/rotation on page 149
- Examine the main health metrics on page 150

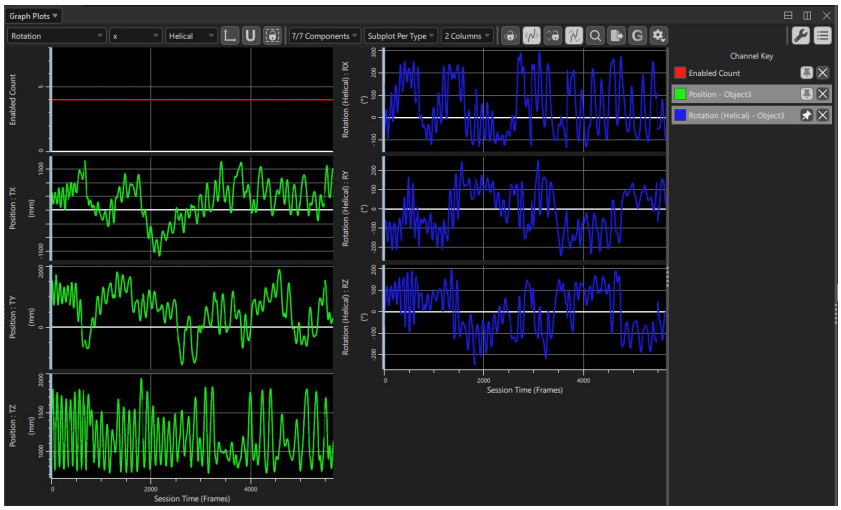
You can obtain additional information about camera health from accelerometer feedback (see Observe accelerometer feedback on page 152) and from examining the camera temperature monitoring (see Monitor camera temperature on page 154).

When you have determined whether any of the cameras need further action to correct any issues, see Fix issues with camera calibration on page 155.

Plot graphs of object count and object pose

The main indicator of the camera calibration being healthy is that objects are successfully tracked and their poses (ie, their position and rotation) are stable and noise-free in all parts of the working motion capture volume.

You can display this information by plotting graphs of object count and object position/rotation using the Graph Plots view (see About the Graph Plots view on page 47 and Graphing your data on page 202).



However, it may not always be obvious that the tracking is failing for a few frames or that the pose of the object is noisy in particular parts of the volume, particularly when dealing with large numbers of objects. In these cases, examining the primary camera calibration health metrics may indicate potential issues. For details, see Examine the main health metrics on page 150.

Examine the main health metrics

In cases where the Graph Plots view does not reveal the source of any issues (see Plot graphs of object count and object position/rotation on page 149), the following primary camera calibration health metrics can help to reveal potential problems.

You can view these scores for all cameras and individual cameras in the System Health Report panel (see System Health Report on page 164), and for individual cameras in the Cameras view (see About the Cameras view on page 43).

 Centroid connection score

The centroid connection score is the percentage of centroids that are connected to labeled object points, calculated over a fixed time window. To be included in the centroid connection score, centroids must be connected to object points.

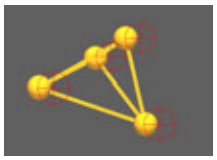
> **Note**
> Static centroids that aren't connected to object points (eg, from unused passive markers at the edge of the volume, or from unmasked reflections on a metallic camera truss) are eventually filtered from inclusion in this score by an online masking process. This online masking affects only the centroid connection score and is used to prevent such centroids from affecting the centroid connection score (it would not be clear if the low score indicated centroids from non-object sources, or poor connection of the centroids associated with the object(s) of interest).

Image error score

The image error score is the average error for those centroids that are connected to labeled object points. The error here is the distance (in pixels) between a centroid and the projection of the associated labeled object point into the associated camera view.

The following examples illustrate common calibration issues:

Example	Calibration issue
	Good/perfect calibration This shows a zoomed section of a camera view. The centroids are displayed as circles with internal crosses to help show the exact centers. All centroids are connected to labeled object points (indicated by the green lines) and so the Centroid Connection score is high (100%). The centroid centers line up with the projections of the object points in this camera view, and the Image Error score is very low.
	Noisy calibration The estimated calibration for this camera no longer perfectly matches the true calibration. The calibration is close enough that all the centroids can still be connected to the corresponding labeled object point, but the projections of those points are further away from the equivalent centroids. This results in a high (good) Centroid Connection score, but the Image Error score is higher (worse) than normal, indicating a problem. This situation might result in some extra noise/jitter in the object's path, particularly as the set of cameras that can see that object change, but in general the object would still be expected to track.

Example	Calibration issue
	**Bad calibration (drift)** The true calibration of the camera has drifted since the initial calibration. Even though the difference is relatively small, it is large enough that that none of the centroids are connected to object point. Unconnected centroids are indicated by being drawn in red. The Centroid Connection score is very low (0% connected). As there are no connected centroids, it is not possible to compute the Image Error score. Depending on the number of cameras similarly affected, the tracking may start to show more severe noise/jitter and the object might start to occasionally fail to track in some parts of the volume.
	**Bad calibration (bump/knock)** The true calibration of the camera significantly differs from the software's stored calibration. This may have been caused by the camera being knocked or deliberated moved since it was last calibrated. The Centroid Connection score is very low (as in the *Bad Calibration (drift)* example) and again the Image Error score is not computed. The cameras affected to this extent do not contribute at all to the tracking of objects. This might result in the object failing to track in parts of the volume (depending on the extent of coverage redundancy, primarily the overlap between cameras view frustums).

For information about the meaning of the colors of the centroids in the Cameras view, see About the Cameras view on page 43.

Observe accelerometer feedback

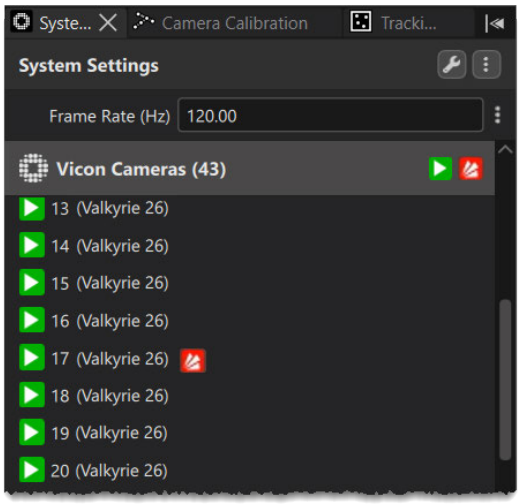
When a camera's accelerometer measurement exceeds its bump threshold, bump notifications are shown in the System Health Report.

Where it is possible to use automated healing, these warnings can largely be ignored; but in certain situations it can be useful to use accelerometer bump notifications to identify problematic cameras and then use the manual **Recover Camera Pose** operation (see Recover Camera Pose on page 159) to correct those cameras.

When the bump notifications are required for the manual process of identifying the problematic camera(s) and then using Recover Camera Pose, it may be useful to enable their display in the System panel and Workspace camera views.

To display bump notifications in the System panel and Cameras view:

1. From the **Settings** menu, select **Preferences**.
2. Go to the **System Health** section and select **Show Bump Notifications Per Camera**.
   Bump notifications are now displayed for individual cameras in the **Vicon Cameras** list in the **System** panel.



   On Vicon cameras with accelerometers, the status indicators flash blue when the camera is bumped and (on Valkyrie and Vantage cameras only) the display changes to indicate a bumped camera.

In addition to the bump notification warning, the System Health Report also provides a Camera Accelerometer section, which displays a graph showing the maximum accelerometer signal for any camera. This is useful for showing when the cameras accelerometers are detecting motion that may not trigger the bump notification warning but may still be of interest or concern, eg, a door slamming may cause the cameras to momentarily shift but will likely return to their previous position, and the tracking may be affected for a very limited period.

Monitor camera temperature

Several common issues with camera calibration arise from changes in temperature. Ambient temperature changes may cause thermal expansion/ contraction of the camera rig causing camera positions to change from their calibrated values. Internal changes of temperature can lead to internal shifts of lens elements and the sensor that may invalidate calibrated parameters.

For this reason, Vicon cameras, have onboard temperature sensors that can be used to help monitor temperatures. The System Health Report contains a Camera Temperatures section (see Camera Temperatures on page 169), which collates all the temperature sensor information for the cameras that can be found in a camera's properties in the System panel (see Camera properties on page 89).

Generally if there are no observable problems in the tracking of objects and the camera calibration health metrics such as Centroid Connectivity and Image Error do not indicate a problem then changes in temperature can be assumed to be harmless. The temperature warnings are most useful in helping to diagnose issues.

Fix issues with camera calibration

This table shows both the manual and automatic tools available for fixing various types of camera calibration issues.

	Drift - small changes to most cameras	Bumps - large changes to a few cameras	Large changes to most cameras
Manual	Change processing parameters on page 156	Recover Camera Pose on page 159	Full recalibration on page 115
Automatic	Auto Bias Handling on page 158	Auto Recover Camera Pose on page 161	—

Change processing parameters

When the distance between between a centroid and the projection of the corresponding 3D point (model point or unlabeled reconstruction) is too high, the centroid is not associated with that point.

In situations where the true calibration has drifted since the camera calibration process was last run, these distances will become too large and consequently the centroid connectivity score for multiple cameras may start to drop.

To allow the system to tolerate larger than usual image errors and enable those centroids to be associated with the 3D points, and thus contribute to the tracking, change the following parameters in the **Processing** panel.

Environmental Drift Tolerance

- **Reconstruction** section> **Environmental Drift Tolerance**

This parameter applies to the formation of unlabeled reconstructions (which are used to boot objects) and is an uncertainty applied (in mm) to camera calibration to tolerate drift in the calibration due to environmental factors such as temperature change.

When unlabeled reconstructions appear to be noisy, with multiple "ghost" reconstructions appearing close to the true 3D point, centroids that *should* be associated with the same 3D point may not be associated and thus multiple reconstructions are formed.

In this case, increase the Environmental Drift Tolerance until the ghost reconstructions disappear, ie, all the centroids are correctly associated with a single reconstruction.

Reprojection Threshold

- **Object Tracking** section > **Reprojection Threshold** (Advanced parameter)

This threshold (in pixels) is used during tracking when forming correspondences between centroids and model points. If the camera calibration has drifted and correspondences are being missed, increase this value.

Reprojection Threshold is closely related to the Automatic Bias compensation machinery (see Auto Bias Handling on page 158). When this is active, the effective value of this threshold is modified automatically.

If ghost reconstructions are visible close to a model point, this may indicate that the Reprojection Threshold is too low. Increasing the parameter has a similar effect to increasing the Environmental Drift Tolerance, whereby the centroids are now associated with a single 3D point (in this case the model point).

Auto Bias Handling

When small changes occur in the pose (position and rotation) or internal parameters of the camera (eg, through temperature changes that cause the thermal expansion of the rig), this can cause centroids to fail to be labeled as part of a tracked object.

The Auto Bias Handling feature attempts to compute the camera calibration biases and increase the slack used when deciding whether a centroid should correspond to a model point in order to compensate.

To turn Auto Bias Handling on or off:

Either:

1. In the **Processing** panel, ensure the Advanced properties are displayed .
2. Go to the **Camera Healing** section and select or clear **Enable Bias Handling**.

or

- In the **System Health Report**, go to the **Auto Bias Handling** section and select or clear the check box.

By default, Auto Bias Handling is enabled.

The bias correction consumes some additional CPU resources but is unlikely to affect latency for standard tracking.

This parameter is effectively the automated version of the Reprojection Threshold parameter (see Change processing parameters on page 156). Note that if objects are struggling to boot, you may also need to increase the **Environmental Drift Tolerance**.

Recover Camera Pose

Tracker enables you to quickly correct a camera whose position has changed due to having been bumped or moved. To do this you use:

- Any visible markers in the volume and
- The **Recover Camera Pose** feature

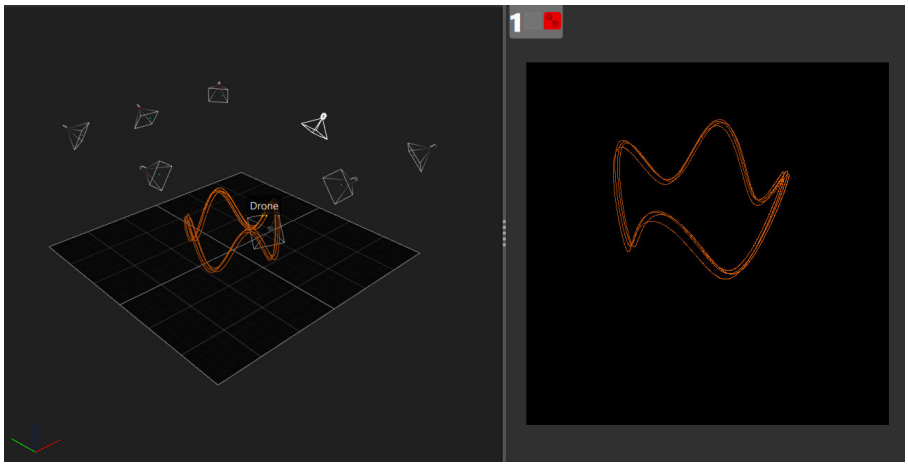
You can use this feature in conjunction with the bump notifications, where you can heal cameras identified as having been knocked by using Recover Camera Pose.

> **Important**
> You can use **Recover Camera Pose** to recover cameras that have been either bumped or moved. This process relies on having enough cameras within a calibrated system to act as a calibration anchor. For this reason, we recommend that it is run on only a small proportion of the cameras in a system. A single camera or a small number of affected cameras can be recovered with good results. If a larger number of cameras is affected, perform a full camera calibration instead (see Calibrating Vicon cameras on page 115).

Correct a bumped or moved optical camera

The following procedure corrects a bumped optical camera (Valkyrie, Vantage or Vero):

1. In the **System** panel, select the camera that was bumped or moved.
2. In the **Camera Calibration** panel, click **Start Recover Camera Pose**.
3. In the volume, move the markers in front of the affected camera.
   In the **3D View** and **Cameras** view, you can see orange trails as the system determines the offset between the camera and the rest of the calibration.



4. When enough of the view and the camera's frustum have been covered (indicated by orange trails showing the path of the markers in the affected camera view, as shown above), click **Stop Recover Camera Pose**.
5. To confirm that the camera has been successfully healed, check that the camera has good Centroid Connectivity and Image Error, either in the **System Health Report** or via the icons in the **Cameras** view (see System Health Report on page 164 and About the Cameras view on page 43).

The camera is now correctly aligned with the rest of the system.

Note that masking of the affected camera is not preserved, so for optimum results, you may need to mask the affected camera again. For information, see Mask cameras on page 118.

Auto Recover Camera Pose

Auto Recover Camera Pose is closely related to the manual Recover Camera Pose operation (see Recover Camera Pose on page 159). A monitoring process checks to see if individual cameras appear to have calibration issues (based on their Centroid Connectivity score – see Examine the main health metrics on page 150), and automatically starts and stops collecting data to use in the recovery process. Any resulting change in calibration is assessed prior to an update being made, including whether the data collected appears to sufficiently cover the camera under assessment.

Auto Recover Camera Pose can heal individual cameras if objects are being tracked and are moving.

> **Note**
> If you decide that a particular camera needs healing, it is almost always better to use the manual **Recover Camera Pose** as this gives you closer control over what data is to be collected and has fewer restrictions than Auto Recover Camera Pose as to the data that can be used to heal the camera.

Understand automatic recovery of moved cameras

When **Enable Auto Recover Camera Pose** is selected, the system detects cameras that have low centroid connectivity scores (below 25%) and may place them under consideration for recovery.

> **Important**
> For Auto Recover Camera Pose to work, at least 50% of the enabled objects must currently be tracked by the cameras.
> For this reason, disable any objects that are not currently being tracked.

For successful automatic recovery of moved cameras, ensure that your system meets the following criteria:

- At least 50% of the enabled objects must currently be tracked by the cameras (see above note).
- The cameras' internal parameters (focal length, radial distortion, etc) do not change.
- The cameras have achieved a stable operating temperature before calibration and before starting tracking.
- Objects are being successfully tracked and the majority of cameras are showing no problems via the camera calibration health metrics (System Health Report on page 164)

If the above criteria are met, the system attempts to recover the position of the camera. It collects data for a short time and if there is sufficient coverage in the Cameras view and the system can find a solution, it applies a new calibration for this camera. This causes the system calibration file to be re-saved to the following default location:

C:\ProgramData\Vicon\Calibrations\LatestCalibration.xcp

System Health Report

The System Health Report has a dedicated Auto Recover Camera Pose section that provides information on:

- Whether the feature is active
- Which cameras are currently under consideration (ie,. may require healing)
- The history of which cameras have had Auto Recover Camera Pose attempted and how many of those attempts were successful

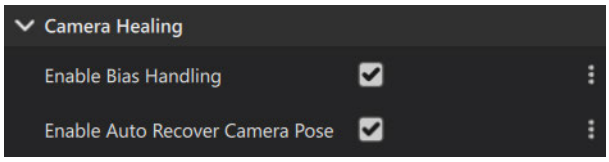
For more information, see System Health Report on page 164.

Deactivate Auto Recover Camera Pose

In some situations, you may need to deactivate Auto Recover Camera Pose, for example, for systems where there is no overhead for the additional processing required, and in some cases where large numbers of moving centroids are generated from non-object sources (eg, reflections from participants' clothing). In this latter case, some other mitigation is often available (eg, by reducing the strobe intensity of the cameras), but in extreme cases it may be better to deactivate Auto Recover Camera Pose, and to manually heal cameras with Recover Camera Pose instead.

To turn off Auto Recover Camera Pose, do one of the following:

- In the **Processing** panel, go to the **Camera Healing** section and clear **Enable Auto Recover Camera Pose**.



Or

- In the System Health Report, go to the Auto Recover Camera Pose section and clear the check box.

System Health Report

System Health Report is a default pane in Tracker. The aim of the System Health Report is to consolidate existing key metrics into a single, easy-to-understand format to help you monitor and evaluate overall system performance. It also provides visibility into cameras currently undergoing healing processes.

The default view of the System Health Report features multiple category headers which help provide a quick glimpse of the current system performance. Each category is expandable so that you can access more granular information about the metrics presented in its header. The metrics in each category are presented either as a discrete value at the current frame or as a thumbnail displaying a trend of recent data in a specified time window.

All metrics presented in the System Health Report can be monitored in the app and accessed remotely via the API.

The following descriptions outline each category, and underlying metrics, in the System Health Report. This can help you decide which metrics to display while tracking.

- Performance on page 165
- Calibration Details on page 166
- Centroid Connectivity on page 167
- Image Error on page 168
- Camera Temperatures on page 169
- Camera Accelerometers on page 171
- Auto Recover Camera Pose on page 172
- Auto Bias Handling on page 172

Performance

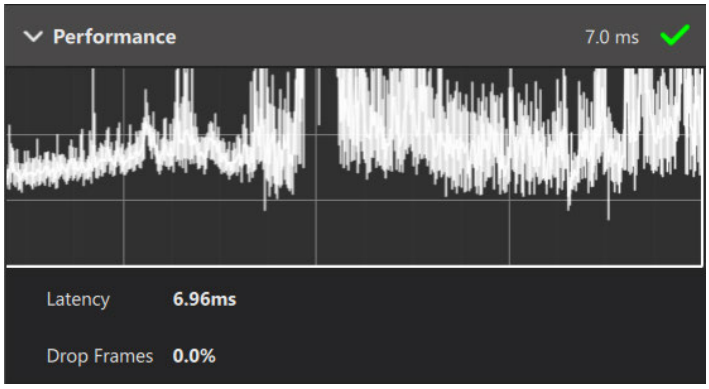
The Performance section helps to assess system performance using data Latency and Drop Frames. These metrics provide an idea of the system's current responsiveness and reliability.

- Latency This refers to the time elapsed (in ms) measured from the mid-point of the camera shutter interval to the moment data is ready to be sent to a client.
- Drop Frames This is the number of unprocessed frames expressed as a percentage of the total frames. Drop Frames occur when the processing of the frame is longer than the frame interval itself. This may happen, for example, when tracking high object counts or when the frame rate is sufficiently high.

The category header provides the current system latency and whether the system is currently processing with or without Drop Frames.

When this category is expanded, it displays:

- A thumbnail graph displaying the latency of the datastream output for the most recent 60 seconds. It is split into the Total Latency (white) and the Delivery Latency (red).
- A table that displays the current system latency as described above and the Drop Frames, expressed as a percentage, over the last 60 seconds.



The latency presented in Performance can also be displayed in Graph Plots by selecting the Datastream Output Latency channel type.

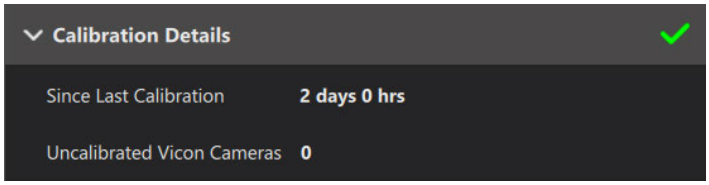
If you want to tweak the performance to affect latency or drop frames, consider changing the settings in the Processing panel (Configure system processing parameters on page 109).

Calibration Details

The Calibration Details section provides details about the state of the system's calibration. The category header indicates whether all enabled cameras are calibrated.

When this category is expanded, it displays:

- The time elapsed since last calibration
- The number of enabled Vicon cameras that are uncalibrated.



If uncalibrated cameras are displayed and you want them to contribute to tracking, be sure to perform a calibration.

> **Note**
> An old calibration does not necessarily indicate an issue with calibration or tracking fidelity.

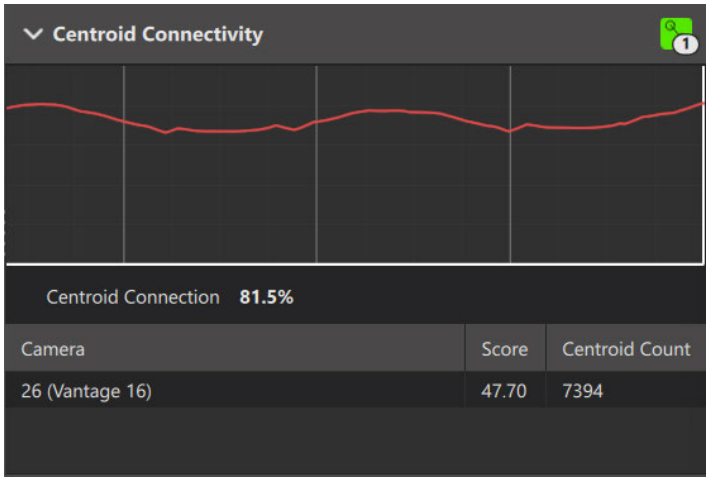
Centroid Connectivity

The Centroid Connectivity section helps to evaluate tracking fidelity using a metric called Centroid Connectivity (also referred to as Centroid connectivity score or score). The score is the total fraction of moving 2D centroids (from each individual camera) that can be labeled as object marker centroids as a percentage of total moving centroids (see also Centroid connectivity score on page 150). A low score indicates poor object tracking.

The category header displays the number of cameras whose centroid connectivity is below 50%. The icon also displays a gradient from red (poor score) to green (perfect score).

When this category is expanded, it displays:

- A thumbnail graph that shows the Centroid Connectivity for the most recent 60 seconds to help assess any potential volatility in tracking.
- A table showing average centroid connection score
- A list of all cameras that are currently healing in an attempt to improve its score. This is only displayed if Auto Bias Handling or Auto Recover Camera Pose is selected in the Processing panel or in the System Health Report. The headings in this list include the camera number, the current score of that camera and the total moving centroids in that 2D view. Cameras continue to undergo healing until its score reaches 100% or the parameters are disabled.



If your centroid connectivity is low, your capture environment or the geometry of your tracked object may have changed. To troubleshoot, consider the following solutions:

- Ensure there aren't any moving reflections in your volume
- Turn on Enable Bias Handling in the Processing pane or in System Health Report.
- Turn on Enable Auto Recover Camera Pose in the Processing pane or in System Health Report.
- Re-calibrate the system (particularly if there is a large deviation in camera temperatures).
- Re-evaluate the tracked object.

You can also display Centroid Connectivity in each camera's individual view. For more information, see About the Cameras view on page 43.

Image Error

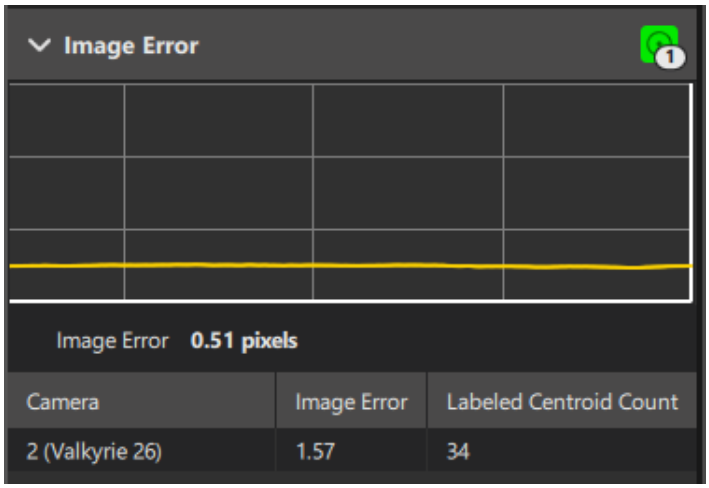
The Image Error section helps assess the accuracy and precision of the current state of tracking. Image Error is a metric that calculates the difference between 2D centroids and their expected location in the image (based on 3D re-projection) expressed in pixels (see also Image error score on page 151). This metric helps you to evaluate the quality of the connected centroids and is the same metric used to assess the quality of the dynamic calibration. As such, if the image error is increasing, a poor calibration or a change in object geometry may be indicated.

The header displays the number of cameras with an Image Error above the threshold (1.0 pixels).

When this category is expanded, it displays:

- A thumbnail graph with the average Image Error across all cameras for the most recent 60 seconds
- A table with the current Image Error
- A list populated with the same cameras as the Centroid Connectivity category. This list shows the corresponding image errors for the cameras and the number of labeled centroids. As a camera improves its score, the Image Error

will normally also increase. In general, a large Image Error may not be desirable if high accuracy and precision is required.



Camera Temperatures

The Camera Temperatures section helps to monitor the body temperatures of each camera connected in the system. This section provides details about potential changes in your capture environment since the system was calibrated. If the system is displaying poor Centroid Connectivity and/or high Image Errors and there is a large deviation in temperature between the current state and when the system was last calibrated, this can indicate that you must perform a new calibration.

The category header can display two different metrics:

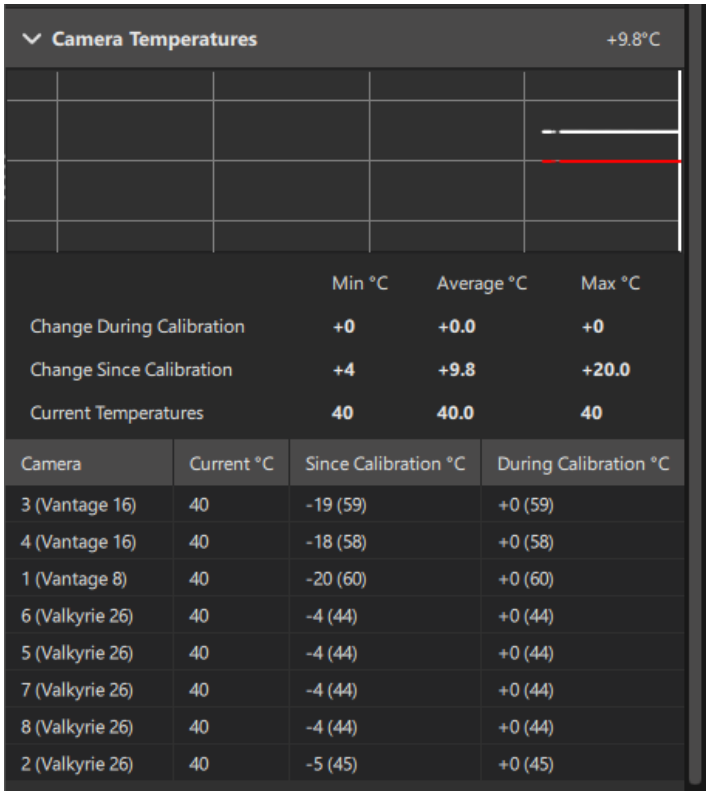
- If the system is calibrated, it shows the average temperature change of all cameras since calibration.
- If the system is uncalibrated, it shows the current average temperature of all cameras.

When this category is expanded, it displays:

- A thumbnail graph that displays two temperatures for the most recent 30 minutes: the average camera temperature at calibration (white) and the current camera temperature (red). All values are expressed in degrees Celsius.
- A table that shows the minimum, maximum and average value for three temperatures:

- **Change during calibration**: This is the change in camera body temperature from the start of calibration. You may not see a difference in this row unless you have a large volume or high camera counts to calibrate or an unstable environment.
- **Change since calibration**: This is the change in camera body temperature since the system was last calibrated.
- **Current temperature**: This is the current camera body temperature of all cameras.

- A list showing a summary of temperature changes for each camera both during and since calibration.



> **Tip**
> To find individual camera temperatures, in the **System** panel, select a camera, ensure the advanced properties are displayed and scroll to the **Temperature** section.

Camera Accelerometers

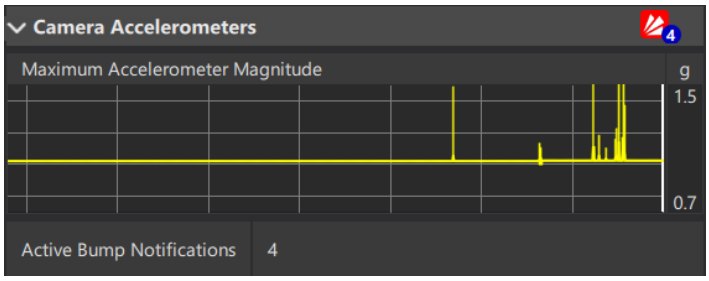
The Camera Accelerometers section helps to monitor the accelerometer readings for all cameras. The accelerometers are used to indicate that the camera body has accelerated beyond its threshold (see bump sensitivity in Camera properties on page 89). It is a crude way to indicate that a camera may have shifted position and thus reduced tracking fidelity.

The category header displays the number of active bump notifications identified in the system.

When this category is expanded, it displays:

- A thumbnail displaying the maximum acceleration measured on any camera within the last 10 minutes.
- A table showing the number of cameras with an active bump notification (see Observe accelerometer feedback on page 152).

> **Note**
> A camera showing a bumped notification does not necessarily indicate a camera that is tracking poorly.

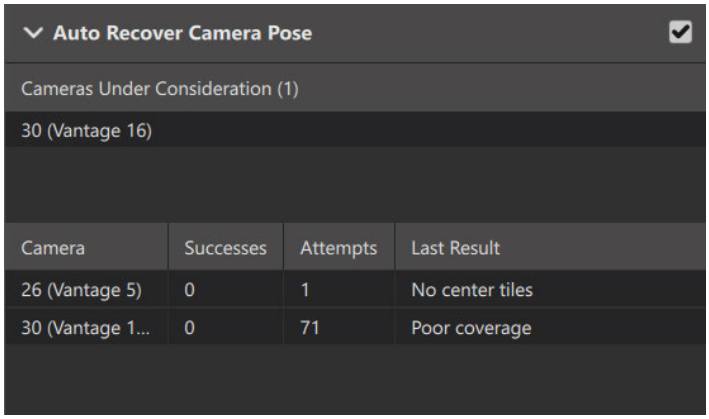


To change the sensitivity of the camera accelerometer, in the **System** panel, select the camera and in the advanced properties, go to the **Accelerometer** section and change the **Bump Sensitivity**.

Auto Recover Camera Pose

This section is used to track any cameras that have been selected for automatic camera pose recovery according to some of the other parameters in the System Health Report. For more information, see Auto Recover Camera Pose on page 161.

The header provides the option to enable/disable the Enable Auto Recover Camera Pose parameter, which is also found in the advanced parameters of the Processing panel (see Configure system processing parameters on page 109).

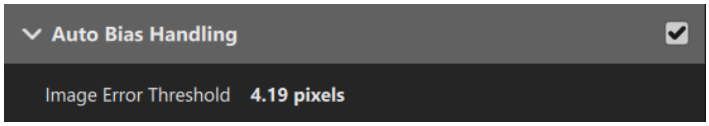


Auto Bias Handling

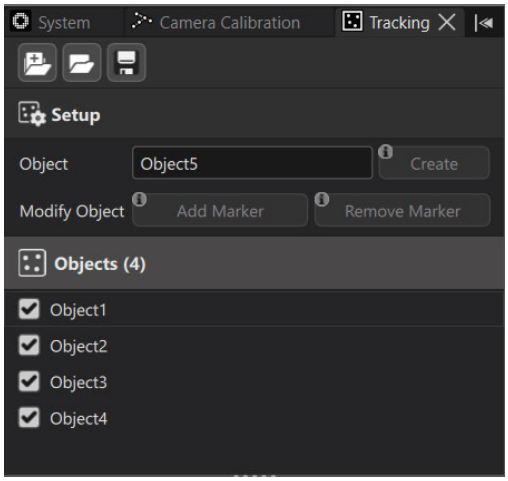
This section is used to track any cameras that have been selected for automatic system healing according to some of the other parameters in the System Health Report. For more information, see Auto Bias Handling on page 158.

The header also features the ability to enable/disable the Enable Auto Bias Handling parameter located in the advanced parameters of the Processing pane.

When expanded, it displays the average Image Error Threshold across all cameras.



Setting up object tracking



To generate 6DOF data for an arrangement of markers in Tracker, you must create objects. For best results, each object must be rigid and consist of at least four asymmetric markers. You create and manage objects in the **Tracking** panel, which is part of the default layout and is displayed as a tab in the left pane.

You can define multiple objects to track many rigid bodies at the same time and you can apply different smoothing filtration presets to each one.

For more information, see:

- Work with objects on page 174
- Understand object booting on page 191
- Understand object evaluation on page 193

Work with objects

To enable object tracking, you create objects in Tracker. The controls for creating and managing objects are all found within the **Tracking** panel (**View** > **Tracking**).

Objects are saved in *.vsk* format and contain information about their specific marker orientation relative to their local coordinate system.

For guidance on how to create and manage objects, see the following topics:

- Create objects on page 175
- Add or remove a marker on an object on page 178
- Create an object preset on page 178
- Add a mesh to an object on page 180
- Change an object's origin on page 181
- Change an object's alignment on page 184
- Manage objects on page 186
- Manage tracking configurations on page 187
- Export an object as a VSK on page 187
- Create a custom calibration object on page 188

Create objects

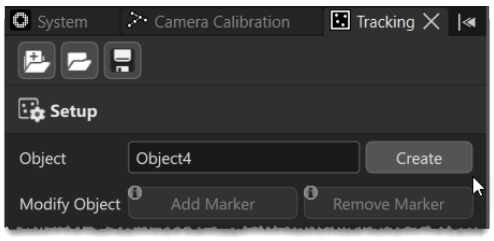
To extract pose data from a set of markers, you create an object in Tracker.

To create an object:

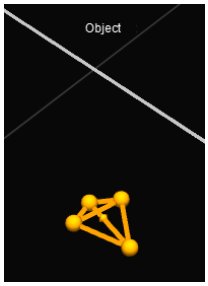
1. Place the object with markers attached in the volume.

> **Tip**
> If you don't see anything in the 3D View, ensure that these options are selected:
>
> - In the **View Filters**, ensure **Unlabeled Markers** is selected.
> - In the **Processing** panel, ensure that **Enable Unlabeled Reconstructions** is selected.
>
> Both of these settings are selected in the Default system file.

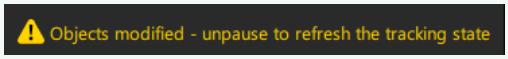
2. Select at least four (five or more is recommended) unassigned marker trajectories by doing one of the following:
   - To select markers individually, press and hold the CTRL key while you click on each marker.
   - To select a group of markers, press and hold the ALT key while you drag around the markers to form a box around them.
3. In the **Tracking** panel, in the **Object** field, specify a unique name and click **Create**. (If you forget this step, see Manage Objects on page 186 to learn how to rename an object after it has been created.)



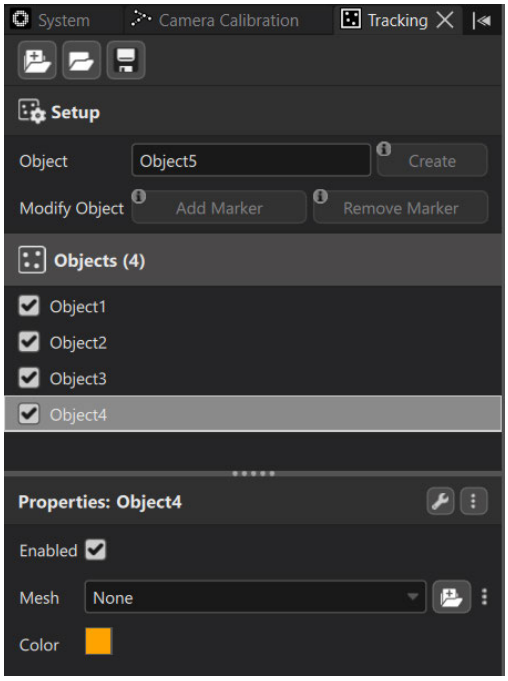
A new object is created with labeled markers and sticks.



The origin of the object is the mean point of all markers. If necessary, you can change this later (see Change an object's origin on page 181).
The orientation of the object is aligned to the orientation of the global coordinate system on the frame it was created. If necessary, you can change this later (see Changing an object's alignment on page 184).

> **Tip**
> If you enter review mode (ie, pause the live data) to create your object, a warning is displayed in the Workspace 
>
> . To see the current pose of the newly created object, you must exit review mode. Although you can create multiple objects while paused, you cannot see the markers, sticks or local coordinate system for the object(s) until you exit review mode.

In the **Tracking** panel, the newly created object is displayed in the Objects list.



> **Tip**
> If your new object has a warning symbol (yellow triangle) next to it, to view information about the issue, hover the mouse pointer over the symbol. For more information, see Understand object evaluation on page 193.

Add or remove a marker on an object

When an object has been created, you can either add or remove a marker to/ from that object.

To add a marker:

1. In either the **Tracking** panel or the **3D View**, select the object.
2. Hold CTRL, select the marker you want to add and then in the **Tracking** panel, click **Add Marker**.
   You can only add a single marker per operation.

To remove a marker:

- Select the marker and in the **Tracking** panel, click **Remove Marker**.
  If the removal of the selected marker results in the object having fewer than four markers, you cannot remove the marker.

> **Note**
> Adding or removing markers does not change the origin location or object orientation.

Create an object preset

An object preset is a set of object-specific properties that enables you to control the amount of filtering performed on a given object. This can help to reduce any jitter or systematic noise in an object, particularly if a marker on the object becomes occluded. It can also help ensure that objects are properly recognized. For information on using an object preset to ensure Tracker recognizes differences between similar objects, see also Resolve issues with object similarity on page 198.

To create an object preset:

1. In the **Objects** list in the **Tracking** panel, ensure that the object to which you want to apply the preset is selected.
2. In the object's **Properties** below, ensure the advanced parameters are displayed  .

3. Depending on whether you want to use an existing object preset for this object, do one of the following:
   - If you want to use an existing object preset, in the **Object Preset** list, select the required preset.
     or
   - If the required object preset does not exist, to the right of the Object Preset list, click **Manage** and in the **Object Presets** dialog box, enter a name in the **Create New Preset** field and then click **Add**.
4. In the **Object Presets** list at the top of the dialog box, select the new preset, then change the properties as required.
   For information on object tracking and the Entrance Threshold, see Why is the Entrance Threshold important? on page 195
   The following steps describe how to set the smoothing properties for translation and rotation.
5. To use 1-Euro filtering for the selected object, select **Filtering Enabled**.
   For detailed information on the 1-Euro filter and how to adjust these settings, visit www.lifl.fr/~casiez/1euro/[12].
6. With **Translation Beta** set to its default value, change the value of **Translation Min Cut-Off** to eliminate jitter during very slow movements.
   Note that decreasing the value of Translation Min Cut-Off reduces jitter but increases lag.
7. When you have finished adjusting the Translation Min Cut-Off value, increase the value of **Translation Beta** by very small increments to eliminate lag during faster movement.
   Note that 0 = filtering on all translation motion; 1 = filtering on very slow translation motion only.
   Follow the same procedure for adjusting the **Rotation Min Cut-Off** and **Rotation Beta**.
8. If you want Tracker to detect the object as static, select **Motion Model**.
9. When you have finished adjusting the properties, click **Close**.
10. In the Tracking panel, make sure that in the **Object Preset** list, the required preset is selected.

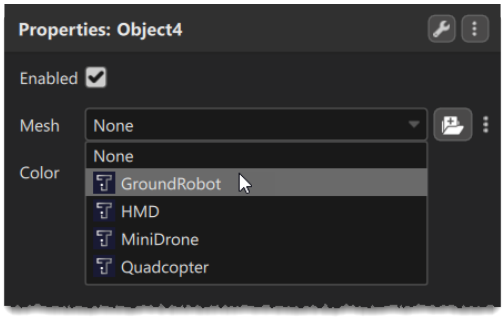
12 http://www.lifl.fr/~casiez/1euro/

Add a mesh to an object

A mesh is a 3D model representation with a root bone that specifies its own coordinate system.

Adding meshes to objects enables you to better visualize them in the Workspace to check that they are correctly aligned and that they give the result that you want.

1. In the **Tracking** panel, in the **Objects** list, select the object to which you want to add a mesh.
2. In the object's **Properties** below, from the **Mesh** list, select the required mesh.



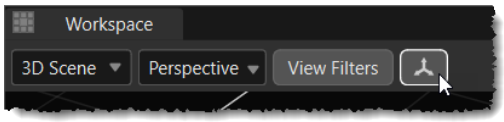
Tracker accepts any mesh in the FBX file format. You can use the installed meshes, or your own FBX files.
To choose your own FBX file, click the **Import mesh** button next to the Mesh list. This enables you to choose an FBX file from its saved location.
The file is copied to the prop mesh folder:
(*C:\Users\Public\Documents\Vicon\PropMeshes*)
It is also added to the Mesh list and is set as the current mesh.

Your mesh is displayed in the 3D View.

Change an object's origin

The object manipulator enables you to specify an object's origin (ie, the center of the physical object in relation to the marker pattern that is tracked by Tracker). You can also change the alignment of its local coordinate system (see Change an object's alignment on page 184).

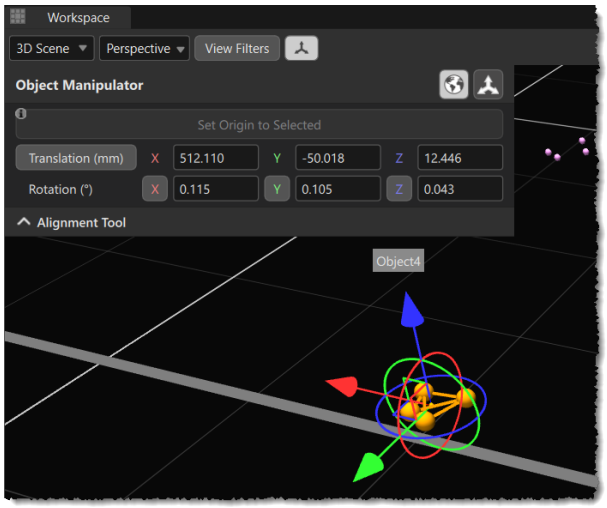
1. Activate the object manipulator:
   a. To pause the live stream, press the space bar or click the **Enter Review** button at the bottom right of the **Workspace**.
   b. Select the object.
   c. In the **3D View**, click the object manipulator button.



> **Tip**
> If you click on the object manipulator while not in Review mode, the dialog box does not appear until you click **Enter Review**.

2. Ensure Global or Local (either the local or global reference frame, as required)  is selected. For details, see Understand local vs. global reference frames on page 183.

3. In the 3D View either:
   - Drag an axis to move the origin to the required location; or
   - Enter values in the **Translation** fields;



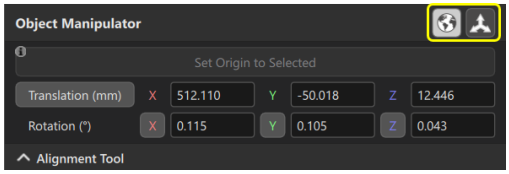
When you resume streaming (ie, un-pause), the object's orientation is updated.

> **Tip**
> To scale the Manipulator, on the numeric keypad, press + (scale up) or - (scale down).

Understand local vs. global reference frames

Note that the manipulator operates with respect to either the local or global reference frame (corresponding to the object coordinate system or the world coordinate system, respectively). To switch between the two:

- Click the required icon at the top right of the **Object Manipulator**.



Using the global reference frame, you can also move the origin of the object to the global origin by clicking **Translation** 

.

If you use the local reference frame, note the following behavior:

- If you drag an axis, its translation in that axis is noted. When you start streaming again, this resets the local reference frame to this new location (ie, origin Translation is reset to (0, 0, 0)).
- If you enter a numerical value into one of the axis fields, the axis is translated by the specified amount. When you start streaming, the initial origin location persists so the translation still shows the amount specified for the remainder of that sync session.

Change an object's alignment

The object manipulator enables you to change an object's alignment or orientation (ie, to modify its local coordinate system). You can either align each axis manually or use one or more markers or axes to help align your local coordinate system.

For either method, make sure you first pause the live stream.

Align objects manually

With the object manipulator enabled and an object selected, you can either:

- Rotate an axis directly in the 3D workspace; or
- Enter a value in the rotation fields for each axis. You can also specify whether you want this to be a local or global rotation using the reference frame buttons  (see Change an object's origin on page 181).

  If the global reference frame is selected, each axis identifier within Rotation changes to an active state (eg, ). Selecting one of these axes aligns it to its corresponding global axis.

> **Note**
> The object's alignment depends upon the axis that you select:
>  Rotates the object -90 degrees about the global coordinate system's Y-axis
>  Rotates the object +90 degrees about the global coordinate system's X-axis
>  Aligns the object to the global coordinate system

Align with marker or axis

To align an object with a marker or axis:

1. Ensure the object manipulator is enabled and the required object is selected.
2. Click the alignment tool (for more information, see Understand the alignment tool on page 189).
3. Set your primary axis. To do this:
   - In the **Primary Axis** line, select the target type (**Axis**, **Marker** or **Center**), followed by the target.
     - If you chose Axis, you choose the target from a drop-down menu.
     - If you chose Marker or Center, you are prompted to select one or more markers.
   - Select the axis (X, Y or Z) and its direction (+/-)
4. Repeat step 3 for the **Secondary Axis**.
   Note that if the Axis or Target in the Secondary Axis is the same as Primary Axis, the **Align** button is unavailable.
5. Click **Align**.

> **Tip**
> With the system still paused, you can undo (CTRL+Z) or redo (CTRL+Y) the most recent alignment.

Manage objects

Objects and their properties are displayed in the Tracking panel according to Tracker's AutoSave behavior (see Tracker fundamentals on page 21).

For further control of each object in the Objects list in the Tracking panel, right-click one or more objects to display a context menu. This enables you to use these options:

- **Rename** Enables you to rename the selected object. You can also double-click to rename or select the object and press F2 or change its name in the **Object** field.
- **Remove** Removes the selected object(s) from the tracking list.
- **Enable** Activates the selected object(s).
- **Disable** Deactivates the selected object(s).
- **Export** Exports the object as a *.vsk* file with the name you have given the object. By default, objects are exported to *C:\Users\Public\Documents\Vicon\Objects*, but the dialog box enables you to save to any location. You can change the default location within the preferences (see Preferences options on page 59).
- **Use for Camera Calibration** Enables you to use a custom calibration object. See Create a custom calibration object on page 188.

Manage tracking configurations

The top of the Tracking panel displays the controls that enable you to manage your objects. This includes being able to import an object, load a set of objects, or save a set of objects.

To import an object, click  . You can import any object in *.vsk* format.

When you have finished creating your objects, you can save them to a tracking configuration file (MCP file format).

To do this, at the top of the **Tracking** panel, click the **Save tracking configuration** button:

The default location for tracking configuration files is:

C:\Users\Public\Documents\Vicon\Tracker4.x\Tracking

When you want to re-use your tracking configuration, click the **Load tracking configuration** button to re-load the file.

Export an object as a VSK

To export an object as a Vicon Skeleton (VSK) file:

1. In the **Tracking** panel, go to the **Objects** list, right-click on the required object and then select **Export**.
2. In the **Export** dialog box, browse to or enter the location for the object. The default location is:
   C:\Users\Public\Documents\Vicon\Objects
3. Save the VSK.

Create a custom calibration object

You can use a Vicon Active Wand to set up your volume coordinate system quickly and easily (see Set the volume origin on page 124). However, using a larger calibration object (for example, markers embedded in the volume floor and wall) can improve calibration stability and consistency over time.

You can create and export a custom calibration object from any object as described in Create objects on page 175 and Export an object as a VSK on page 187.

When you export the VSK, save it to your calibration objects folder. The default location is:

C:\Users\Public\Documents\Vicon\CalibrationObjects

You can use the custom calibration object to set the origin of your volume.

For detailed information on how to create and use a custom calibration object, see Scale calibration and set a fixed origin on page 139.

Understand the alignment tool

The alignment tool enables you to use different targets and target types to align your object's local coordinate system. The target type dictates the options available for the target, so you must select the target type first.

Alignment tool options

These options apply to both primary and secondary axes.

Option	Description	Target options
Axis	Enables you to select an existing axis – either an axis from the current local coordinate system or the global axis. This is useful if you want to rotate the local coordinate system about a specific axis.	Local X/Y/Z Global X/Y/Z
Marker	Enables you to select a marker – either an unlabeled marker or any labeled marker – to specify the direction of the chosen axis with its axis origin at the current origin of the object. The marker's name is displayed next to Target in the panel **Note**: Unlabeled markers are only identified as **Unlabeled** in the panel.	Labeled Marker Unlabeled Marker
Center	Enables you to select multiple markers and use the center point to specify the direction of the chosen axis with its axis origin at the current origin of the object. To view the markers chosen, hover over the tag.	Labeled Marker Unlabeled Marker

Tips

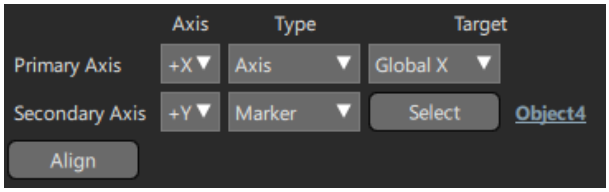
- To draw a box around the markers you want to select, hold down the ALT key and drag.
- To select two or more markers, select one marker and CTRL+click to select the other(s).

Alignment process

When you are selecting the primary axis, this axis is locked in and is aligned exactly to the axis or point as specified.

The secondary axis helps to align the remaining two axes by first creating a plane with the primary axis. The normal to this plane, calculated by taking the cross-product of the primary and secondary axes, creates the third (unspecified) axis. Using the primary axis and this newly calculated axis, the axis specified within the secondary axis can be aligned properly (that is, orthogonal to the primary and third axes).

This is an example of the use of the alignment tool:



In this example, the primary axis of the object is aligned with the global X-axis. The secondary axis is a vector originating at the object origin and in the direction of the Object4 marker. The cross-product of the primary and secondary axes calculates the (unspecified) Z-axis. Using the primary (X) and Z-axis, the Y-axis is then aligned.

Understand object booting

When objects are active in the Tracking panel, Tracker undergoes a process known as booting whenever a set of unlabeled reconstructions first appears in the 3D View. Booting is the process which enables an object to begin tracking. For efficient booting, we strongly recommend that each object has a unique pattern of markers (see Understand object evaluation on page 193) and that you set the Entrance Threshold appropriately. This is particularly helpful in cases of frequent occlusion and results in more consistent tracking with fewer dropped frames.

Entrance Threshold

The Entrance Threshold is the minimum proportion of markers in an object that must be visible to successfully boot that object. You can set it between 0.00 and 1.00, with 1.00 representing 100% of the markers on that object.

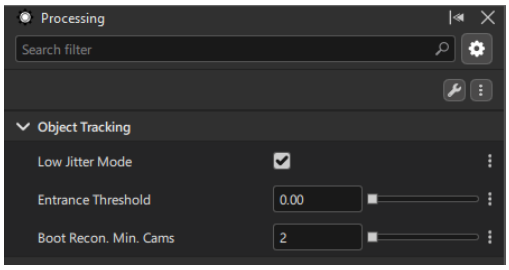
If the Entrance Threshold is low, it is easier to boot the object, but more likely that pose of an object will be initialized incorrectly, potentially resulting in the use of markers that are actually on another object (ie, object swapping). For example, if you have a 10-marker object with an Entrance Threshold of 0.3 or lower, tracking can start as soon as any three markers are detected in the correct pattern (three is the minimum number required to track). This means that the object could be confused (and be considered similar) with any other object that has the same or similar pattern of three markers, regardless of the other markers on that object.

If the Entrance Threshold is high, it can be more difficult for the system to boot an object, particularly if the object geometry makes it too difficult to see a high enough proportion of markers simultaneously. This may be the case for an object resting on the ground, for example: any markers on the underside may not be visible to the cameras. However, this has the added benefit of conducting a more thorough evaluation of an object's marker geometry when assessing similarity. As such, you may not want the entrance threshold for object tracking to be the same as the entrance threshold used for object evaluation.

Configuring the Entrance Threshold

In Tracker, you can set the **Entrance Threshold** in the following ways:

- Globally, for all objects in the Object Tracking section of the **Processing** panel



- Locally, for an individual object using an object preset (see Work with objects on page 174).

  Note, you do not need to set any filtering if you only want to control specify an **Entrance Threshold** for that object.

Understand object evaluation

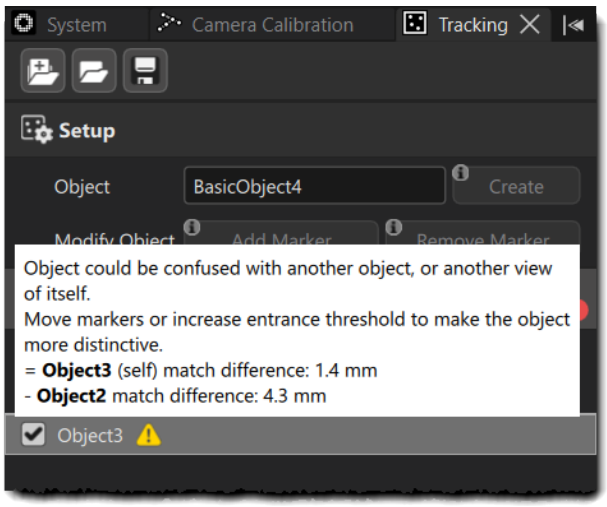
In Understand object booting on page 191, it was explained that unique marker configurations would facilitate efficient and accurate object initialization. However, following this guideline can be difficult under two common scenarios:

- When there are a large number of similarly sized objects, as unique marker patterns may be difficult to generate
- When using smaller objects, as the average distance between markers is proportionally smaller

To avoid any issues with object similarity, Tracker can provide an objective assessment of all active objects. Object evaluation is an automated process which runs in the background to systematically compare the similarity of the pattern of markers for each object that is enabled in the Tracking panel with every other enabled object, including itself. This can help to reduce any errors with object booting.

When you create, load or change objects, Tracker evaluates all objects and if there is a high likelihood of confusion between objects, it flags each object with a yellow warning triangle in the Tracking panel.

To view specific information about the type of similarity, hover the mouse pointer over the warning symbol.

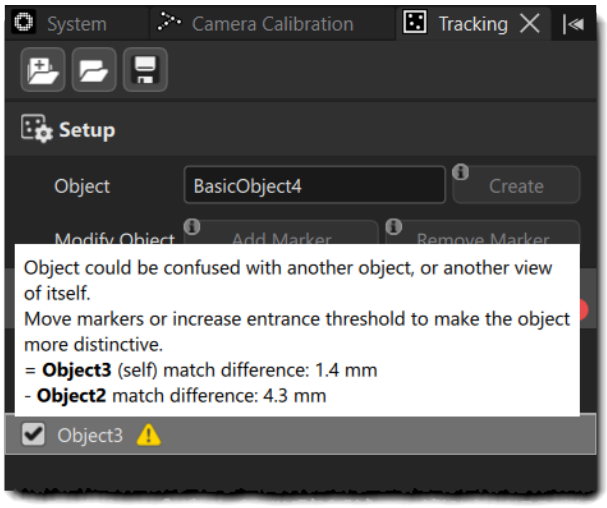


For details about the way Tracker evaluates the similarity of objects and the actions you may need to take, see these topics:

- How does object evaluation work? on page 194
- Control object evaluation on page 200

How does object evaluation work?

Tracker's object evaluation feature compares each object that is enabled in the **Tracking** panel with every other enabled object, and displays a warning when a match between a pair of objects is detected. The warning tooltip indicates which other object (or objects) that the current object may be confused with, and the match distance (in millimeters). The match distance is the approximate average displacement between the object markers, when the two objects have been aligned to the closest matching pose.



The average match distance is controlled by the **Object evaluation warning threshold (mm)** setting in the **Preferences** (Set user and system preferences on page 56). A match distance lower than this setting will trigger an object confusion warning.

A match distance of 0 indicates that the object pair is identical (or to be more precise, the fraction of markers specified by the object's **Entrance Threshold** (see Why is the Entrance Threshold important? on page 195) is identical to a pattern of markers on the other object). Conversely, a large match distance indicates the objects are easy to distinguish, and unlikely to be confused.

> **Info**
> The ability to resolve markers in distinct patterns depends on the camera resolution, and the typical distance of objects from the cameras. A volume with low camera density will generally require larger objects (with proportionally large marker patterns) to compensate.

Why is the Entrance Threshold important?

The concept of the Entrance Threshold was previously described in Understand object booting on page 191. This parameter is also used for object evaluation as it specifies the minimum proportion of markers to be used as part of the object evaluation process. In terms of the importance of Entrance Threshold for object evaluation, let's consider these examples again:

- If the Entrance Threshold is low for Object Evaluation, it will be more likely that objects will be flagged for similarity. If you have a 10-marker object with an Entrance Threshold of 0.3, two objects would only need to match only 3 markers on each to be considered similar regardless of how different they are as a whole.
- If the Entrance Threshold is high, a more thorough evaluation of an object's marker geometry when assessing similarity can be conducted.

There is a subtle but important distinction here; for object booting, you may want to use as low an entrance threshold that can reliably boot your objects but a high entrance threshold for object evaluation so you can do a more thorough assessment. While the entrance thresholds may end up being the same for both processes, they need not be synchronized and may allow each function to perform better when not synchronized.

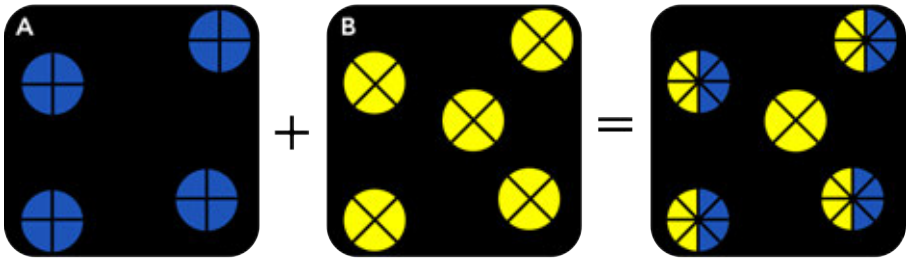
As such, Tracker defaults to an entrance threshold of 1 for object evaluation so that all markers are considered when evaluating similarity and uses a separate entrance threshold to be used for booting. This should be suitable for the tracking scenarios where all markers (or a high proportion of markers) can be used for the booting of an object.

For details on how to change the Entrance Threshold for object evaluation, see Configuring object evaluation on page 199.

Examples of object similarity

To help understand object similarity, consider the following examples. Each example uses the default Tracker setting for object similarity (i.e. an entrance threshold of 1).

Different number of markers

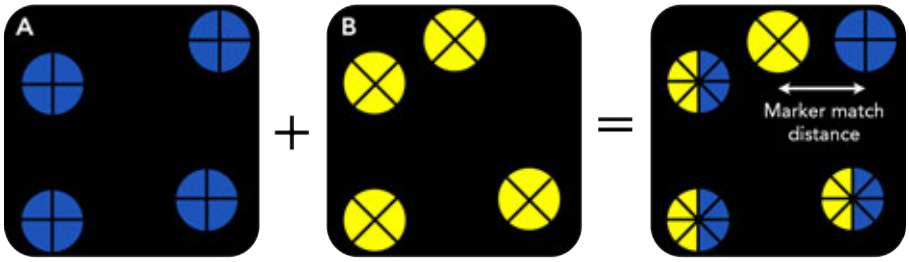


Object A has 4 markers, while Object B has 5 markers:

- Object A matches object B, match distance = 0 (The match distance is the approximate average displacement between the object markers, when the two objects have been aligned to the closest matching pose.)
- Object B doesn't match object A (which doesn't have enough markers to meet the Entrance Threshold for object B).

If we reduced the object evaluation Entrance Threshold to 0.8 for object B, it would then match object A identically (with match distance 0).

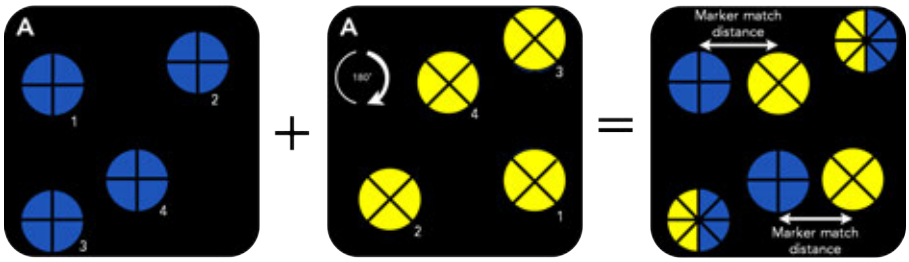
Moved marker



Object A and object B both have 4 markers, one of the markers on object B has been moved. The distance between the markers is the marker match distance, as indicated on the above diagram.

- Object A matches object B with an average match distance of the marker match distance/4 (3 markers match exactly, with distance 0).
- Object B matches object A with the same average match distance.

Self-similarity (rotational symmetry)

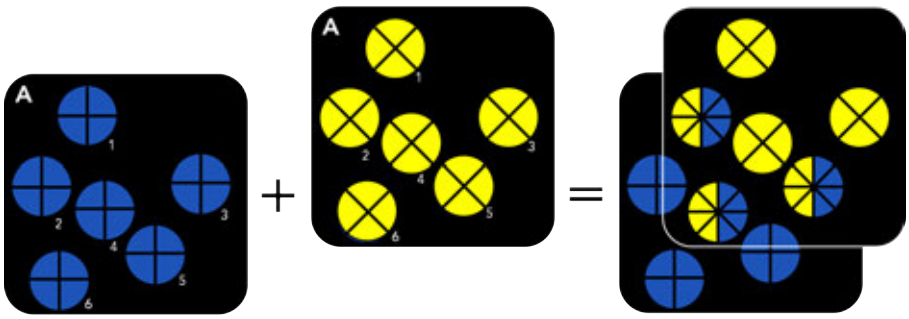


Here we have rotated object A by 180° clockwise.

- Object A matches itself with average match distance of the marker match distance/2 (2 markers match exactly, with distance 0).

Rotational symmetry is a problem because it means Tracker will have difficulty in determining the correct orientation of the object. You would notice this as unpredictable rotational errors or 'flipping' the object when starting tracking.

Self-similarity (repeated marker pattern)



Here object A has 3 markers repeated in the same pattern - (1, 3, 4) matches (2, 5, 6) exactly.

This is not necessarily a problem if Entrance Threshold is set to 1, but if Entrance Threshold is set to <= 0.5 then Tracker could start tracking from either pattern subset, and cannot distinguish between the two. You would notice this as an unpredictable translational error when starting tracking.

To learn how to eliminate object similarity matches, see Resolving Object Similarity on page 198.

Resolving Object Similarity

If objects are confused with one another, physically adjust the placement of one or more markers on the affected objects to make their patterns distinct.

After one or more markers has been moved, to update the object evaluation and ensure correct tracking, in the Tracking panel make one of the following changes:

- Remove the current object from the **Objects** list and recreate a new object.

Or

- Use the **Remove Marker** button to remove each marker that was physically moved and the **Add Marker** button to add it back to the object.

Both options ensure the correct relationship between the current marker locations and the local coordinate system of the object is maintained.

Configuring object evaluation

As mentioned, the default setting in Tracker is to set the object evaluation entrance threshold to 1 and not have it linked to the booting entrance threshold. However, in certain instances, it may not be desirable to use the default settings for object evaluation; that is, you may want to use an Entrance Threshold lower than 1. To do this:

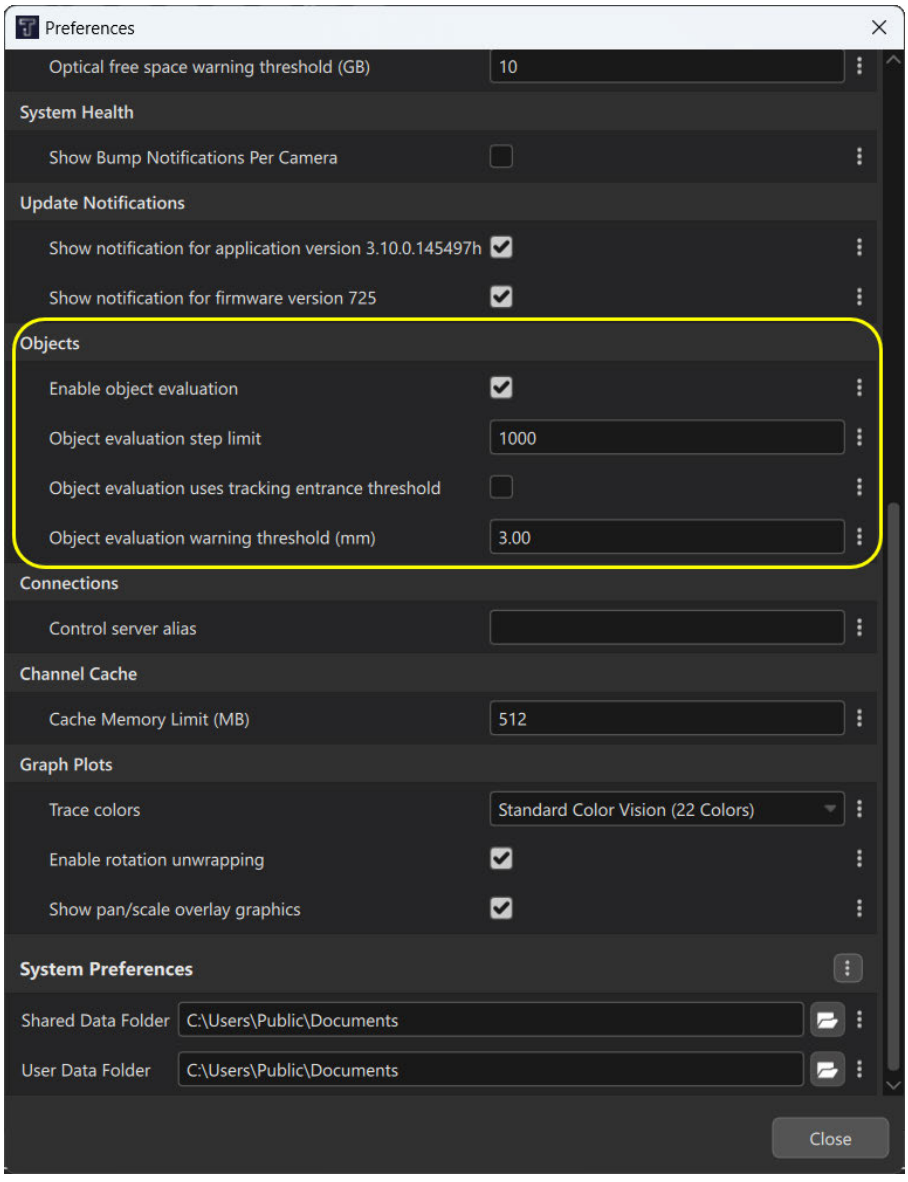
- Open the **Preferences** dialog box (**Settings** > **Preferences** or Shift+P).
- In the **User Preferences**, scroll to the **Objects** section and select **Object evaluation uses tracking entrance threshold** .
  Now the tracking and object evaluation thresholds are the same.

To learn how to configure booting thresholds, see Understand object booting on page 191.

Control object evaluation

To turn object evaluation on and off or to change the sensitivity of the evaluation to object differences:

1. Open the **Preferences** dialog box (**Settings** > **Preferences** or Shift+P).
2. Scroll to the **Objects** section.
3. You can change the following settings:



- Enable Object Evaluation - Turn object evaluation on or off: the default is selected (on). When selected, each object is compared to all the others for possible confusion.

  > **Important**
  > If you have many objects or objects with many markers, evaluation can take a long time, so if you want to minimize latency, we recommend turning off Object Evaluation (see Control object evaluation on page 200).

- Object evaluation step limit - Maximum number of iterations (steps) that are expended in evaluating each object pair. Increasing this value may enable the evaluation to find more potential problems, particularly for objects with many markers, but at the cost of increased computation time. The default limit is 1000 steps.
- Object evaluation uses tracking entrance threshold - Controls which entrance threshold is used for object evaluation. If enabled, object confusion evaluation uses the entrance threshold specified in the Processing panel or the object preset if one was set for an individual object. An entrance threshold less than 1 results in more object confusion warnings. If disabled, the entrance threshold for object confusion evaluation is set to 1 and all markers are used to evaluate similarities between objects. The default is disabled.
- Object evaluation warning threshold - A warning is displayed if the match distance in millimeters between a pair of objects falls below this threshold. (The match distance is the approximate average distance that the object markers would have to move to exactly match the other object, or part of it.) You may want to adjust this setting so that it is higher than the typical level of noise (resulting in 3D positional jitter) in your volume. The default threshold is 3 mm.

4. Click OK to accept any changes and close the dialog box.

Graphing your data

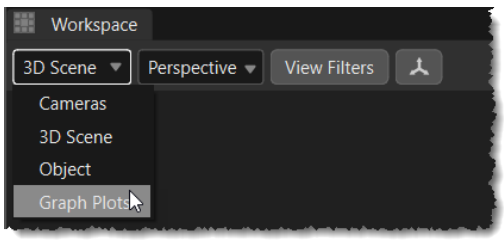
In the Graph Plots view, you can display and select your data (for example, x, y, and z components of a marker trajectory) in graph format, plotted against time – see About the Graph Plots view on page 47.

> **Note**
> For definitions of the terminology used for graphing, see Graph Plots terminology on page 209.

To graph data in a Graph Plots view:

If you *do not* currently have a graph displayed in a Graph Plots view:

1. In the **Workspace**, select the **Graph Plots** view.

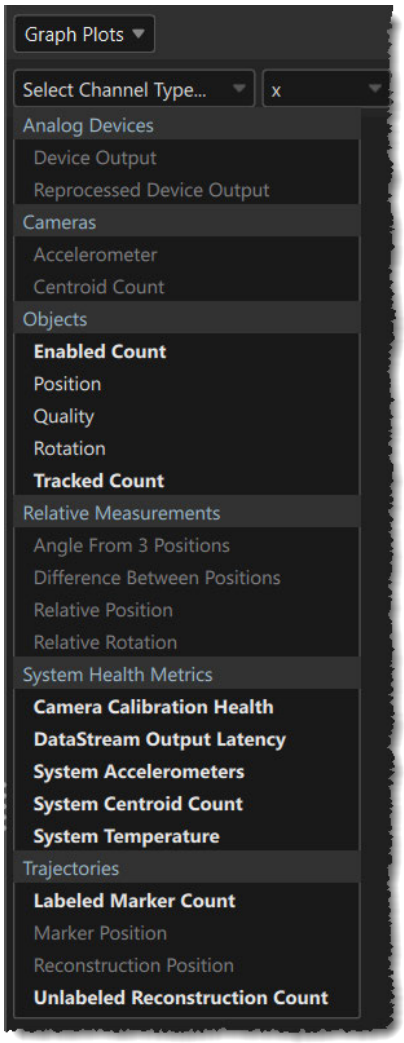


> **Important**
> If the Graph Plots view displays **No active channels** or a similar message, make sure you either have a live system connected (see Prepare your Vicon Tracker system on page 8) or are in review mode (see Review captures on page 250).

2. To plot a channel type, select the relevant channel. You can choose to display an independent channel or a dependent channel. If you choose a dependent channel, you must also select a channel source which can be:
   - An analog device in the **System** panel
   - An object in the **Tracking** panel

- A marker or object in the **3D View**
- A camera in the **System** panel or **Cameras** view

At the top left of the Graph Plots view, click the channel types dropdown menu to display a list of channel types:



> **Tip**
> Any channel type listed in white is available for the selected channel source. If a channel source is not selected, only independent channel types are available for viewing in the current graph plot.
> Relative measurements require the selection of two or more channel sources.
> For more information about channel types, see Graph Plots reference on page 227.

3. Change the displayed data within the active channel using additional controls in the Graph Plots toolbar. For more information, see:
   - Change the type of graphed data on page 211 (eg, derivatives)
   - Change the layout of graphed data on page 214
   - Change the scale of graphed data on page 216

To add a graph trace to a subplot in Graph Plots:

If you already have at least one channel active in a Graph Plots view and want to add a trace to a subplot:

1. Make sure you have pinned all the channels that you would like to keep (see Manage channels on page 224).
   If a channel is not pinned, it will be removed from the Graph Plots view.
2. When you have pinned all the desired channels, you can:
   - Add a trace to the existing graphs (that is, adding the position data of Object2 to an existing graph of position data of Object1).
   - Change the processing applied to the active channel type by selecting one of the graph plot modifiers (see Change the type of graphed data on page 211).
   - Select new channel type from the **Channel Types** menu.
   - Select a new channel source by clicking on the device, object, or marker from the relevant panels or views.
3. If you want to keep the newly added channel and add additional channels, you must pin it.

> **Note**
> In general, any newly selected channel source or type is displayed according to the settings that are currently selected within the Graph Plots toolbar. The duration of data displayed in the trace depends on whether you are reviewing live or captured data.
> If your system is live, the duration of the trace is limited initially by the **Live data range** (see Change the scale of graphed data on page 216) or the **Pause Buffer Size** (see Tracker fundamentals on page 21), whichever is shorter (in seconds).
> If your system is in review mode, it displays the trace for the entire capture duration.

Customize graph plots

To customize the data displayed in the Graph Plots view, first choose your data (see Change the type of graphed data on page 211) and then make sure the desired channels are pinned (see Manage channels on page 224).

When you have chosen the required channel type(s) to plot, you can customize the way your data is displayed by selecting options from the Graph Plots toolbar to make the following changes.

- Change the layout of graphed data on page 214
- Change the scale of graphed data on page 216

> **Tip**
> To toggle the display of all available Graph Plots toolbar options, click the Show advanced button on the right of the toolbar.

As you customize your graph plots, refer to Graph Plots mouse actions on page 222 to understand how to control the full behavior of the Graph Plots view.

Manage graph plots

After you have added all the desired channels and customized the layout of the Graph Plots view, you may want to:

- Lock the current selection of channels using the **Lock channel selection** button. When enabled, if you click potential channel sources, channels are not added or removed.
- Save the current Graph Plot layout (including pinned channels) or load a previous Graph Plot layout using **Graph Settings**.

Channel lock

When the **Lock channel selection** button is activated, selecting or de-selecting channel sources does not add or remove graph channels to the current Graph Plot view.
You can still change the layout of your Graph Plots but not the channels themselves (see Change the layout of graphed data on page 214).

Graph settings

Graph settings enable you to save and load a specific layout within the Graph Plots view. This includes any channels that are pinned (even if they are not present in the current session) or locked using the **Lock Channel Selection** button. It also includes the settings specified within the graph plot modifiers (Change the type of graphed data on page 211).

Graph settings only apply to the Graph Plot view and are a subset of the overall View settings (see Customize the Tracker user interface on page 24). This means:

- You can load different Graph Plot layouts while maintaining the current Tracker layout.
- Loading a View setting will load the graph settings that were specified as a part of that View configuration.
- Graph settings do not have a specific AutoSave feature but are included as part of the View settings AutoSave (see Tracker fundamentals on page 21).

If you want to use your current Graph Plot layout in the future, use the Graph Settings menu. From here you can open the Manage Graph Settings dialog box, where you can import, save or delete Graph Settings files.

To save a new graph setting:

- On the **Graph Plots** toolbar, click Graph Settings  , then click **Manage** and click the Save button.

> **Tip**
> Before saving your graph settings, remember to pin all desired channels in a Graph Plots view or use the **Channel Lock**.

To load a previous graph setting:

- On the **Graph Plots** toolbar, click Graph Settings  and either select from the list or click **Manage** and import the required setting.

Export data

To export the current graph channel data to a CSV file, click the CSV Export button  . For more information, see Exporting data to CSV on page 256.

Graph Plots terminology

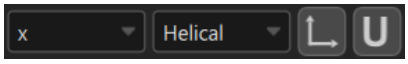
The following definitions are used to explain creating and using graph plots.

Term	Definition
Active channel	A channel that is either selected or pinned
Channel	A stream of data that can be added to a graph plot
Channel cache	The amount of channel data stored either in memory or disk. The **Cache Memory Limit** (see Preferences options on page 59) controls the threshold when data is to be written to disk.
Channel source	A selection that provides one or more data channels and includes: • Vicon Camera • Analog device • Object, marker, or unlabeled reconstruction
Channel type	A channel source may provide multiple data streams of different types, which may be selected from the dropdown menu on the Graph Plots toolbar
Component	One part of a channel data value
Dependent channel	A channel that is only available with a channel source selected (eg, object position)
Frame number	A number that increments sequentially for each frame of system data received
Gap	A time period of missing channel data (eg, because tracking was interrupted)
Independent channel	A channel that is available without a channel source being selected (eg, DataStream Output Latency)
Live mode	A mode that displays data from the connected live system
Pinning	This locks a channel on a graph plot even if the channel source is de-selected

Term	Definition
Review mode	A mode that displays data from the selected review clip
Sample	A set of channel component values, taken at a single point in time
Sample number	A number that increments sequentially for each channel sample received. Most channels are sampled at the system frame rate, so the sample number is equal to the frame number. However, analog sources may be sampled at a multiple of the system frame rate.
Subplot	A subdivision of the graph plot containing one or more traces of the same type
Trace	The visual representation of a single component of a channel data stream on the graph plot

Change the type of graphed data

In the Graph Plots view, the graph plot modifiers in the toolbar control the type of output for the active channel(s).



The graph plot modifiers enable you to:

- Plot derivatives on page 212
- Change the rotation type on page 212
- Plot channel magnitude on page 212
- Change the units on page 213

Note that some options are only available when you select **Show advanced** . This is noted in their descriptions.

> **Note**
> In a similar way to selecting different **Channel Types** with an **Active Channel**, graph plot modifiers will:
>
> - Add an additional set of subplots according to the last selected graph plot modifier (if applicable) if the channel is **pinned**
> - Change the graph type according to the last selected graph plot modifier (if applicable) if the channel is **not pinned**.

Plot derivatives

To choose whether to plot normal channel data (**No Derivative**) or a derivative (**Velocity** or **Acceleration**) for the selected channel(s), on the Graph Plots toolbar, click the **Derivative order** dropdown menu 

Change the rotation type

To change the rotation type, on the Graph Plots toolbar, from the **Rotation format** list, select the required display:

- **Helical** format. Axis-angle representation comprising a unit vector that indicates the axis of the rotation, scaled by the angle describing the magnitude of the rotation about the axis.
- **Euler** format. Representation composed of 3 rotations about the axes of a coordinate system in a particular sequence.
  The Tait-Bryan set of Euler angle conventions are supported.

This is an advanced Graph Plot modifier.

Plot channel magnitude

To plot channel magnitude for the active channel(s), on the Graph Plots toolbar, select the **Channel magnitude** button.
Depending on the current selection, when Channel magnitude is activated, the relevant magnitude is displayed.
See Graph Plots reference on page 227 for more information on how the magnitude may affect your active channel.

Change the units

To change the units for the active channel(s), on the Graph Plots toolbar, select the **Change selected channel units** button U. Choose from the following options:

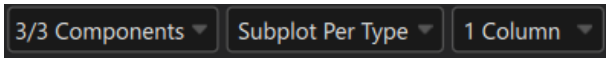
- **Angle** Choose between degrees (°) or radians (rad)
- **Length** Choose between millimeters (mm), centimeters (cm) or meters (m)

Note that the units for each component is displayed with its label along the y-axis.

This is an advanced Graph Plot modifier.

Change the layout of graphed data

In the Graph Plots view, the graph plot layout options in the toolbar control the way in which data is displayed.



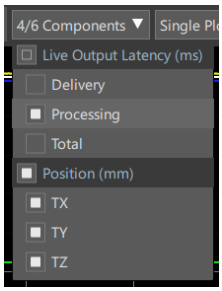
To display these options, on the right of the toolbar, select **Show advanced** .

> **Note**
> Changing the layout options affects the display of all graphs within that view, so if you want a different layout for different channels, open another Graph Plot view.

The graph plot layout options enable you to:

- Choose graph plot components on page 214
- Choose subplot layout type on page 215
- Choose number of columns on page 215

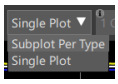
Choose graph plot components



From the **Components** list, you can choose which components to display.

- Select or clear the check box on a channel type to show or hide all components of that channel.
- Select or clear the check box on a component to show or hide that component.

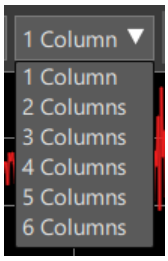
Choose subplot layout type



From the **Subplot** list, select the required layout type:

- **Subplot Per Type** (the default layout type)
  - A subplot is created for each component of each channel type.
  - If multiple channels of the same type are active, each subplot will have one trace per channel.
- **Single Plot** mode
  - All traces are added to a single plot.
  - If different channel types are plotted in this mode, the axis label shows only common information (if any), such as the units.

Choose number of columns



From the **Subplot column** list, select the required number of columns used to lay out subplots (1 by default).
If your layout mode is selected to **Single Plot**, this list is inactive.

Change the scale of graphed data

In the Graph Plots view, you can control the x- and y-scale of the data plotted by selecting options on the toolbar, in context (right-click) menus, and by dragging with the mouse.

- Use the toolbar options for scaling on page 216
- Use the context menu for scaling on page 218
- Use the mouse for scaling on page 220

Use the toolbar options for scaling

In the Graph Plots view, the graph plot scaling options in the toolbar enable you to control the type of scaling that is possible and whether or not it is locked to prevent further changes.

To prevent any changes to the x-axis (deactivates pan/zoom and fit), select the **Lock x-axis** button.

When you select the **Scale to fit x axis** button, the axis range is automatically adjusted to fit the data currently stored in the channel cache (Graph Plots terminology on page 209).

- When auto-fit is on, the mouse pan/zoom is turned off.
- Fits to min/max of data range.

To prevent any changes to the y-axis (deactivates pan/zoom and fit), select the **Lock y-axis** button.

When you select the **Scale to fit y axis** button, the axis range is automatically adjusted to fit the data currently stored in the channel cache (Graph Plots terminology on page 209).

- When auto-fit is on, the mouse pan/zoom is turned off.
- Fits to min/max of data range + 5% padding

> **Note**
> When either of the **Scale to fit** modes   is disabled, the graph axes revert back to their previous (non-fitted) state.
> This may result in a graph which is not properly scaled and you may need to manually scale or use the context menu to visualize your data again.

An additional option at the bottom right of the Graph Plots view enables you to specify the Live data range.

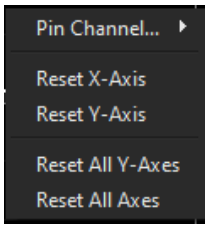
The **Live data range** list enables you to choose the default time axis range (ie, x-axis) and, as a result, the amount of data stored in the channel cache (Graph Plots terminology on page 209).
Note if the duration of the **Pause Buffer Size** (setting in preferences) is less than the **Live data range**, selecting a new channel source to create an active channel will only display data initially for the duration of the **Pause Buffer Size**.
This control is not displayed when Tracker is in Review mode.

Use the context menu for scaling

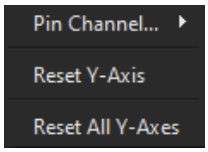
In a Graph Plot view, you can right-click to display a context menu.

The context menu options depend on where the right-click occurred:

Graph Plot



Y-axis



X-axis

The following table describes the function of each of the options.

Option	Function
Pin Channel	Allows you to pin or unpin a channel from the current subplot. See Manage channels on page 224 for more information.
Reset X-Axis	Resets the range of the time axis. This affects the x-axis range for all subplots.
Reset Y-Axis	Resets the range of the y-axis of the current subplot
Reset All Y-Axes	Resets the range of all y-axes within the Graph Plot view
Reset All Axes	Resets the range of both the x- and y- axes for all subplots within the Graph Plot view.
Relative Time Display	The default time index is always relative to the current frame. In this mode, the current frame is at 0 while the previous frame is at -1. De-selecting this option displays the time relative to the beginning of the current session (for more information on sessions, see Tracker fundamentals on page 21). In this mode, the frames count from 0 which represents the start of the current session. **Note**: This option is only available when Tracker is not in Review mode. When Tracker is in Review mode, the time displayed is always the session time display.

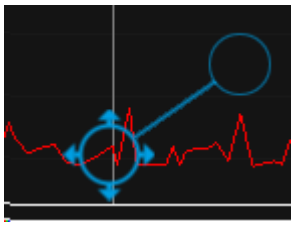
Use the mouse for scaling

Graph plots have a range setting (where range is the minimum and maximum value on the axis). Zooming changes the length of the range; panning changes the central point of the range.

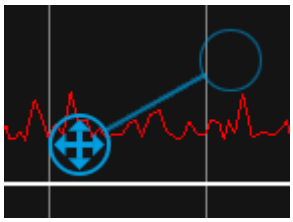
The following table describes the mouse actions required to zoom or pan a graph plot. A full list of mouse actions can be found at Graph Plots mouse actions on page 222.

Required zoom or pan	Mouse action
Zoom on a single axis only	Right-click and drag on the required axis.
Zoom on both the x- and y-axis	Right-click within the subplot window and drag the subplot.
Pan on a single axis only	Middle-click and drag on the required axis.
Pan on both the x- and y-axis	Middle-click within the subplot window and drag the subplot. Note that the middle-click can be substituted by the wheel button or by simultaneously pressing both the left and right mouse buttons.

When you zoom or pan, a bold circle is displayed, representing the deadzone. If the mouse pointer is within the deadzone, no zoom or pan change occurs. A faint circle is drawn when the mouse pointer is outside the deadzone, highlighting the current pointer position.



Zoom indicator



Pan indicator

When multiple x-axes are present, zooming or panning one affects all the x-axes (they are linked).

Note

For zooming and panning to work in this way, ensure that neither axis is locked or auto-scaling.
To check, verify that:

- The **Lock axis** buttons and the **Scale to fit** buttons, both horizontal   and vertical  ), are *not* selected.
- **Show pan/scale overlay graphics** is enabled within Preferences (see Preferences options on page 59)

Graph Plots mouse actions

You can use the following mouse actions in a Graph Plot.

Task	Keys and mouse
Pin/unpin channels	Right-click on: • Subplot or axis, and select **Pin Channel**, then select the channel to pin or unpin. • Line in the **Channel Key**, and select **Pin All** or **Unpin All**.
Remove all channels from the subplot and the Channel Key	Right-click on a line in the **Channel Key**, and select **Remove All**.
Reset axis pan and zoom to default	Right-click on subplot or axis and select the required **Reset** option to reset either the X-axis, Y-axis, or both axes.
Switch between relative and session live time	When not in Review mode, right-click on subplot or x-axis and select or clear **Relative Time Display**. Default is selected. • **Relative Time** (the default) displays frame numbers relative to the latest system frame • **Session Time** displays frame numbers counting from the start of the current sync session (the current sync session number is indicated on the time bar in square brackets after the frame number). See Tracker fundamentals on page 21 for more information on a sync session.
Pan (slide) both x- and y-axis	Click middle button (or wheel, or both buttons) + drag on subplot
Pan (slide) axis only	Click middle button (or wheel, or both buttons) + drag on required axis
Zoom on both x- and y-axis	Right-click and drag (or CTRL+ wheel) on subplot
Zoom on single axis only	Right-click and drag (or CTRL+ wheel) on required axis

Task	Keys and mouse
Zoom to selection	ALT+right-click and drag on subplot (sets x- and y-axis ranges to fit a rectangle drawn with the mouse) To cancel, left-click.
Scroll subplot up/down	Rotate mouse wheel back or forward on subplot or axis
In Review mode, scrub one frame backward or forward	Press the A or S key

Manage channels

These topics explain how to use controls in Graph Plots to manage the channels, including how to display or hide the key and how to pin and unpin channels:

Display or hide a key for the graph

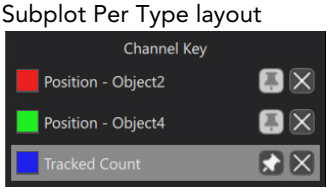
To toggle the display of selected or pinned channels, select the **Channel Key** button on the far right of the Graph Plots toolbar.
For more information, see Use the Channel Key on page 224.

Use the Channel Key

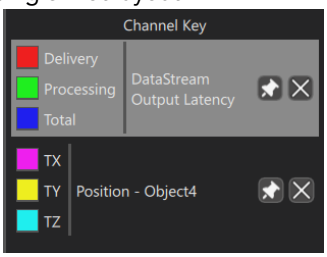
The Channel Key pane displays a list of the active channels. If the subplot layout is set to Single Plot, component names are also displayed, with each channel component displayed in a different color.

> **Tip**
> To pin/unpin all or remove all channels, right-click a line in the key and select the relevant option.

Subplot Per Type layout



Single Plot layout



- Color patch – The color used for corresponding traces.
  For information on how to change the colors used for each trace, see Preferences options on page 59.
- Component name
- Channel name
- Pin button – Click to toggle the relevant channel's pin status.
- Remove button – Click to remove the relevant channel. This removes its traces from the graph and de-selects any input channel sources.

- Dependent channel entries are highlighted when all their input channel sources are selected.
- Independent channels are highlighted when they are the current channel type.

Select and pin channels

Selecting a channel source automatically adds one trace for each of its components, creating subplots as required for each channel component type. Deselecting a channel source removes the traces (and any empty subplots).

Pinning a channel prevents removal of traces on deselection.

To pin a channel, do either of the following:

- Open the Channel Key and click the relevant Pin button for the component and channel name

or

- Right-click in a Graph Plots view, select **Pin Channel** and then select the relevant component or channel (see Graph Plots mouse actions on page 222).

Pinning is useful for building plots of disparate types, or comparing multiple selected channels to a reference channel.

Show or hide channel statistics

Select the **Show channel statistics** button to display a tooltip when you hover the mouse pointer over a subplot. The tooltip indicates the current value, mean, and standard deviation of the traces on the subplot.

- Mean and standard deviation are computed over the range of data stored in the channel cache.
- For live data, the size of this range is controlled by the live data range (see Change the scale of graphed data on page 216)
- For review data, the whole clip range is used.

Set the opacity of lines between gaps in channel data

Select the **Change opacity** button and move the slider to change the opacity of lines drawn between gaps in the channel data

Graph Plots reference

This section provides details in addition to those in the rest of the Graphing your data on page 202 section, about options and modifiers found within the Graph Plots view.

For a description of all channel types and the channel sources in each type, see Channel types on page 227.

For information on the calculations used within Graph Plots, including modifiers, see the relevant topic:

- Derivatives on page 229
- Rotation unwrapping on page 230
- Magnitude on page 231

For a more general introduction, see Graphing your data on page 202.

Channel types

Analog Devices

- **Device Output** The output from an analog device
- **Reprocessed Device Output** The output from an analog device re-calculated from the raw analog source data. This is slightly more expensive to compute than the Device Output and should produce the same result when not in Review mode, but may have fewer gaps in Review mode.

Cameras

- **Accelerometer** The movement measured for the camera from the onboard accelerometer. This is given as a unitless vector scaled by acceleration due to gravity; the number varies, depending on the orientation of the camera. The magnitude of the accelerometer at rest is approximately 1, with some variation according to calibration.
- **Centroid Count** The number of centroids detected by the camera. (Note that in Review mode, this channel is only supported if the camera's Grayscale Mode is set to Auto or All.)

Objects

- **Enabled Count** The number of objects enabled in the **Tracking** panel
- **Position** The object position relative to the volume origin
- **Quality** The object quality. This is a measure of the fit of the object to the observed marker positions, and is influenced by the accuracy of the object model, and the camera coverage and accuracy of camera calibration at the current object position and rotation
- **Rotation** The object rotation relative to the global coordinate system axes
- **Tracked Count** The number of objects currently tracked

Relative Measurements

- **Angle From 3 Positions** The angle ABC defined by the positions A, B and C (objects, markers or reconstructions)
- **Difference Between Positions** The difference between two positions (objects, markers or reconstructions)
- **Relative Position** The position of object B relative to object A (in the frame of reference of object A)
- **Relative Rotation** The rotation of object B relative to object A

System Health Metrics

- **Camera Calibration Health** Assessment of the overall camera calibration health
  - Plots Image Error and Centroid Connectivity. For more info on either of these metrics, see Monitor system health on page 149.
- **Datastream Output Latency** Latency measured for the live low-latency datastream port
  - Delivery latency is the time difference between the start of data capture at the cameras and delivery of the data to the application. This covers internal camera processing, network transfer and host PC data receipt.
  - Processing latency is the time difference between the data delivery time and processed datastream output. This covers host PC processing to track the observed objects and output tracking data.

  - Total latency is the sum of the delivery and processing latency.
- System Accelerometers The movement measured over all cameras from the onboard accelerometer
  - Mean magnitude is the average acceleration vector magnitude of all cameras. This is given as a multiple of the acceleration due to gravity, with 1 indicating normal acceleration at rest.
  - Maximum magnitude is the highest acceleration vector magnitude of any camera. This is given as a multiple of the acceleration due to gravity, with 1 indicating normal acceleration at rest.
- System Centroid Count The total number of centroids detected in all cameras. (Note that in Review mode, this channel is only supported if the camera's Grayscale Mode was set to Auto or All.)
- System Temperature The temperature measured for all cameras
  - Current mean is the current average temperature of all cameras
  - Calibration mean is the average camera temperature measured at the end of the data collection stage of a Calibration Wave operation

Trajectories

- Labeled Marker Count The number of object markers currently tracked
- Marker Position The marker position relative to the volume origin
- Reconstruction Position The unlabeled reconstruction position relative to the volume origin
- Unlabeled Reconstruction Count The number of marker positions reconstructed from camera centroids but not labeled as part of an object

Derivatives

Default derivatives

For most channel types, the derivatives are computed using a central finite difference approximation.

First order (velocity):

$x'(t + 1/2) = x(t + 1) - x(t)$

Where x is the channel sample value and t is the channel sample number.

Note that first-order derivatives are offset by half a sample with respect to the input channel.

Second order (acceleration):

$x''(t) = x(t + 1) - 2x(t) + x(t - 1)$

Rotation derivatives

First order rotational derivatives (rotational velocity) are computed using the relative rotation between successive samples:

$R'(t + 1/2) = R^{-1}(t)R(t+1)$

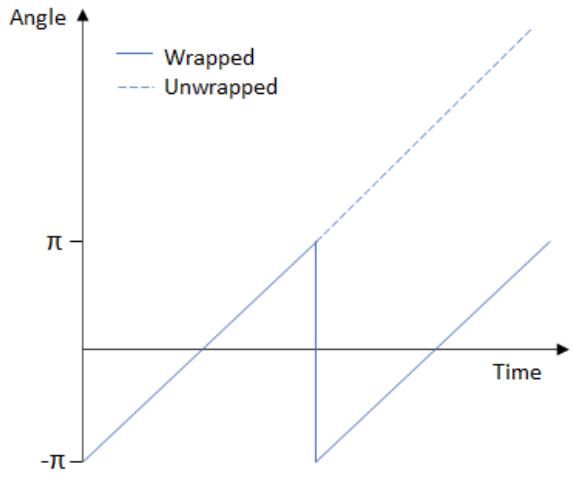
Second order rotational derivatives are computed using the central finite difference of the first order rotation derivative:

$R''(t + 1) = R'(t + 3/2) - R'(t + 1/2)$

Rotation unwrapping

The angle range (-π, π) radians is sufficient to describe all orientations. However, as an object continues to rotate in the same direction and approaches these boundaries, a flip in orientation (and sign) can be observed to keep the angle within the (-π, π) radians range. Rotation unwrapping allows you to strategically add factors of 2π to the angle to generate equivalent representations of the same orientation. This helps to remove any discontinuities in the data.

For example, an object rotating through an angle of 4π might result in a trace like this:



Note that unwrapping doesn't necessarily tell you the trajectory of orientations the object went through to get from A to B, and the results are not easy to interpret if the axis of rotation changes. Gaps in the object tracking can also cause the rotation unwrapping to restart.

Rotation unwrapping is enabled by default, but can be disabled in user preferences (**Settings** > **Preferences** > **Graph Plots** section > **Enable rotation unwrapping**).

> **Note**
> Rotation unwrapping only applies to graph plots and does not apply to other outputs such as those expressed in the Datastream SDK.

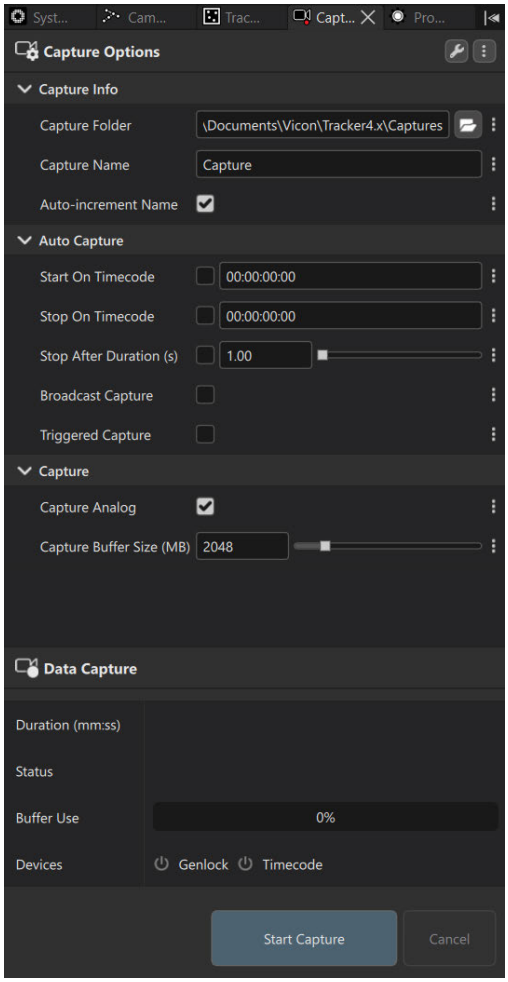
Magnitude

Magnitude can be used to compute the resultant of a vector quantity, or the absolute value of a scalar quantity. Some common use cases include:

- Magnitude of position = distance from origin
- Magnitude of rotation = angle rotated about the rotation axis
- Magnitude of difference between or relative position = distance between
- Magnitude of velocity = speed

Capturing data

> **Note**
> The Capture panel is not displayed by default. To view it as a tabbed panel on the left of the Tracker window, from the **View** menu, select **Capture**.



Configure capture settings and review recordings of capture data, using the controls on the **Capture** panel.

> **Note**
> Some properties are available only when advanced properties are displayed (at the top right of the Capture panel, click Advanced Parameters 

To capture data in Tracker:

1. In the **Capture** panel, specify your requirements for recording live data. Ensure you specify the required capture folder and a unique capture name.
2. At the bottom of the **Capture** panel, click **Start Capture**. The menu bar changes to display 'Capture Active'

For more information, see:

- Capture live data on page 234
- Capture properties on page 244

Capture live data

> **Important**
> Before you start capture, be sure to check that the appropriate options are selected in the Capture panel (see Capture properties) on page 244.

To capture live data:

1. Ensure your system is connected and calibrated and that Tracker is not in Review mode.
2. Open the **Capture** panel (**View** menu > **Capture**).
3. In the **Capture Info** section, ensure the **Capture Folder** location is specified as desired.
4. In the **Capture Name** box, enter a name for the new capture. If you want a number to be automatically appended to the file name and incremented on each successive capture, ensure **Auto-increment Name** is selected.
5. Do one of the following:
   - If you don't want to select any further parameters, go to step 7; or
   - If your capture requires any further setup, for example, if you are using remote triggering, in the **Auto Capture** section, supply the necessary information:
     - **Start/Stop on Timecode** To start and end capture data at a specified timecode, select the check box and enter the required timecode.
     - **Stop After Duration** To end the capture automatically after a specified number of seconds, select this check box and enter the required number of seconds.
     - **Broadcast Capture** To send a remote trigger over the network via UDP to control capture start and stop times, select this check box.
     - **Triggered Capture** To receive a remote trigger to control capture start and stop times, select this check box. A trigger can originate from either a voltage signal connected to your Vicon system via a Vicon connectivity device (Vicon Lock) or over the network via UDP.

   If you are sending or receiving a signal via UDP, also specify the **Port** for the capture and from the **Address** list, select the required IP address.

For information on the format of UDP broadcast and trigger notifications, see UDP capture broadcast/trigger on page 236.

For more information on the capture settings, see Capture properties on page 244.

6. If you selected the **Start On Timecode** check box, start the timecode source from which the data capture is to be triggered; otherwise, go to Step 7.
7. Under the **Capture** section, select the check boxes next to each data source you want to capture. For more information, see Capture properties on page 244.

> **Tip**
> By default, Tracker 4 will capture raw camera data (.x2d) but all data available for review is captured within the review file (.mcp). If you do not select the check box next to **Capture Processed Data** (or **Capture Analog Data**), you may not see your data when opening it for review.

8. When you are ready to begin capturing, click **Start Capture**.
   The **Duration** number (mm:ss) increases as the capture proceeds.
   If you did not specify a number of seconds in the **Stop after Duration** box or if you decide to end the capture before the specified time, click **Stop Capture** when you have finished capturing.
   To abandon the capture without saving any data, click **Cancel**.

Each successful capture will be listed in the **Captures** section of the **Review** panel. If required, you can play back the captured data by double-clicking the capture name and then clicking the Play button at the bottom right of the **Workspace** view pane (see Review captures on page 250).

> **Tip**
> To optimize your workflow and app layout for capture, consider using the **Capture** view settings (see Customize the Tracker user interface on page 24).

UDP capture broadcast/trigger

Vicon Tracker supports a simple UDP protocol to broadcast when capture has started. Tracker can also receive these messages, which can be used to trigger a capture remotely over a network.

For information on how to set up remote triggering in Tracker, see Capture live data on page 234, and in particular, Step 5.

To access the supplied example code (C++), see Supplied example code on page 243.

> **Important**
> If you use **Broadcast Capture**, packet information is automatically populated based on the way Tracker is currently configured.

Example notifications

The XML file contains the following notifications:

Start notification

The following example shows a Start notification. Note that the broadcast must fit into one UDP packet.

The indents in the following example are for clarity: the actual packet is not indented. White space between tokens is removed.

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<CaptureStart>
    <Name VALUE="dance"/>
    <Notes VALUE="The pets ants crime deer jump. "/>
    <Description VALUE="The crowd pencil pets alert fold deer. With welcome
practice representative complete great? Or jolly tiny memorise thread. However
wool insect pipe! "/>
    <DatabasePath VALUE="D:/Jeremy/Susan/Captures/Take"/>
    <Delay VALUE="33"/>
    <PacketID VALUE="33360"/>
</CaptureStart>
```

Where:

`Name`	The name of the capture, which is used as the filename for the capture files, for example `<Name>.x2d`. Note that the name must be unique for the given `DatabasePath`.
`Notes`	Any notes provided
`Description`	Any description provided. Avoid very long description strings as the broadcast must fit into one UDP packet. If it does not, the broadcast is not sent.
`DatabasePath`	The target path for the capture files. If `DatabasePath` is different from the **Capture Folder** (specified in the **Capture Info** section as described in Capture live data on page 234), Tracker automatically changes the active directory to match `DatabasePath.`
`Delay`	The number of milliseconds that the broadcast is made before the capture starts. This delay enables clients to do any preparation required to respond.

`PacketID`	A unique number that individually identifies the packet. It is incremented for each packet generated. Use it to discard duplicate packets that are delivered by UDP. (This can happen if there are multiple paths between the broadcasting and listening machines.)

Stop notification

The following example shows a Stop notification. It is a notification that capturing has stopped.

Note that writing the file to disk may not be complete. Wait for the corresponding Complete notification before trying to open the file.

Possible values for the result are:

- SUCCESS - Everything was ok.
- FAIL - Everything was not ok. Perhaps the disk ran out of room, or the system was unplugged. You may get a truncated file.
- CANCEL - The user stopped the capture process. There will not be a Complete notification.

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<CaptureStop RESULT="SUCCESS">
    <Name VALUE="dance"/>
    <DatabasePath VALUE="D:/Jeremy/Susan/Captures/Take"/>
    <Delay VALUE="33"/>
    <PacketID VALUE="33361"/>
</CaptureStop>
```

Complete notification

The following example shows a Complete notification. It indicates that the captured file is ready at the path specified. Note that:

- When capture is complete, buffers have yet to be flushed to disk.
- If the file is on a remote drive, it may be captured locally and then copied to the final location. This may take some time.

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<CaptureComplete>
    <Name VALUE="dance"/>
    <DatabasePath VALUE="D:/Jeremy/Susan/Captures/Take"/>
    <PacketID VALUE="33362"/>
</CaptureComplete>
```

Timecode Start notification

The following example shows a Timecode Start notification. It is generated when the system is armed. Note that:

- Capture starts when the system receives the timecode specified.
- Additional notifications may be generated if the start timecode is updated after the system is armed.

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<CaptureStart>
    <TimeCode VALUE="0 38 10 17 0 0 0 4"/>
    <Name VALUE="slip"/>
    <Notes VALUE="The last ants great blade jump. "/>
    <Description VALUE="The truthful pencil pets ants crime deer. With geese
trail representative complete crowd? Or jolly toothbrush slip thread. However
worried insect nest! "/>
    <DatabasePath VALUE="D:/Captures/Take/DayOne/Final"/>
<PacketID VALUE="33364"/>
</CaptureStart>
```

Where:

`TimeCode` is represented as a sequence of integers delimited with spaces.

- Hours
- Minutes
- Seconds
- Frames
- Sub-Frame (Always zero)
- Field
  - 0 - Even Field
  - 1 - Odd Field
- Standard
  - 0 - PAL
  - 1 - NTSC
  - 2 - NTSC Drop

- 3 - Film at 24fps
- 4 - NTSC Film
- 5 - 30Hz exactly

- Sub-Frames Per Frame (the multiple of the timecode rate that the system is running at)

Timecode Stop notification

The following example shows a Timecode Stop notification. Note that additional notifications may be generated if the Timecode Stop is updated after the system is armed or possibly even capturing.

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<CaptureStop>
    <TimeCode VALUE="0 46 27 15 0 0 0 4"/>
    <Name VALUE="slip"/>
    <DatabasePath VALUE="D:/Captures/Take/DayOne/Final"/>
    <PacketID VALUE="33365"/>
</CaptureStop>
```

The values for `TimeCode` are as listed in Timecode start notification on page 240.

Duration Stop notification

The packet is generated when the system is armed, or immediately prior to the capture being started.

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<CaptureStop>
    <Duration FRAMES="12867" PERIOD="32865" TICKS="5553087"/>
    <Name VALUE="memorise"/>
    <DatabasePath VALUE="D:/Take/DayOne/Final/Susan"/>
    <PacketID VALUE="33367"/>
</CaptureStop>
```

Where:

`Duration` is the number of frames that will be captured.

The packet may contain extra information describing the frame rate:

- `PERIOD` is the number of clock ticks between each frame
- `TICKS` is the number of ticks in each second

The frames per second of the system can be calculated as `TICKS/PERIOD`. This representation of the frame rate avoids rounding errors for rates such as NTSC, which cannot be stored in a double without a loss of precision.

```
<Duration FRAMES="12867" PERIOD="653254" TICKS="135000000" />
```

Supplied example code

The examples are provided in C++ and require the *boost* library for communications.

1. CaptureBroadcastMonitor shows how to monitor for and decode the capture notifications described above.
2. RemoteStartStop shows how to package and send the packets to trigger capture start and stop.

Capture properties

The **Capture** panel contains these components:

Capture Info section

Property	Description
Capture Folder	Enter or browse to the location of the folder in which to store captured data. Note: by default, at least two files are saved for each capture: the raw camera data (.x2d) and the motion capture file (.mcp) Default: *C:\Users\Public\Documents\Vicon\Tracker4.x\Captures*
Capture Name	Enter a suitable name that will enable you to identify the capture. This forms the first part (root) of the capture name. If Auto-increment Name is selected (see below), Tracker automatically adds a numerical suffix to the root capture name for each subsequent capture, for example, Capture001, Capture002, Capture003, etc. Note: If the Capture Name matches any file name within the Capture Folder, Tracker will not allow you to select **Start Capture**. Default: Capture
Auto-increment Name	If selected, appends a number at the end of the root capture name for each capture in a sequence consisting of multiple captures. Default: Selected

Auto Capture section

You can configure Vicon Tracker to automatically capture data using these controls:

Property	Description
Start on Timecode	Select this check box and specify the timecode at which you want the capture to automatically start, using the format. `hh:mm:ss:ff` where: `hh` = hours (0-23), `mm` = minutes (0-59), `ss` = seconds (0-59), `ff` = frames (0-24 for PAL/SECAM, 0-29 for NTSC For NTSC, the separator character changes between a colon (`:`) for non-drop frames and a semicolon (`;`) for drop frames. For further details on the use of timecode functionality in Vicon systems, see the *Vicon Vantage Reference Guide* or *Vicon Systems Setup Guide*. Default: Cleared
Stop on Timecode	Select this check box and specify the timecode at which you want the capture to automatically stop, using the format. `hh:mm:ss:ff` where: `hh` = hours (0-23), `mm` = minutes (0-59), `ss` = seconds (0-59), `ff` = frames (0-24 for PAL/SECAM, 0-29 for NTSC) For NTSC, the separator character changes between a colon (`:`) for non-drop frames and a semicolon (`;`) for drop frames. For further details on the use of timecode functionality in Vicon systems, see the *Vicon Vantage Reference Guide* or *Vicon Systems Setup Guide*. Default: Cleared
Stop After Duration	To end the capture automatically after a specified number of seconds, select this check box and enter the required number of seconds. Default: Cleared, 1.00 seconds
Broadcast Capture	Select this check box to enable broadcast capture functionality. This allows external systems on the local PC or network to be notified when Tracker has initiated a Capture. Default: Cleared
Triggered Capture	Select this check box to enable triggered capture functionality. This allows another app on the local PC or network to trigger a capture within Tracker.

Property	Description
Port	Specify the computer port number to be used for triggered capture. Default: 30 Address Select the IP address to be used for triggered capture. The selections available within this dropdown are dependent on your specific PC configuration but you can choose to specify All available IPs or choose a specific IP address Default: All

Capture section

Specify the type of motion data to be captured by your Tracker system.

Property	Description
Capture Analog	Select to capture analog signals from any connected analog devices. Default: Selected
Capture Processed Data	Select to capture marker images visible to the Vicon optical cameras. It is not recommended to clear this parameter if you want to review your captured data. Default: Selected
Capture Buffer Size	Specify the required buffer size for capturing, in MB. Default: 2048

Reviewing data

In Tracker, you can review either live data or offline data.

For more information, see:

- Review live data on page 248
- Review captures on page 250

Review live data

Live review can be thought of as a retrospective tool that enables you to examine recent past data that is no longer than the duration of the **Pause Buffer Size** (see Configure system processing parameters on page 109).

All data that you can access via Graph Plots (see Graphing your data on page 202) is available for review. The data that is available is determined by the duration of the **Pause Buffer**, an advanced property that is configured in the **Processing** panel (for details, see Live Review on page 22).

You can review live data for longer than the pause buffer, but you must add this data as an active channel in **Graph Plots**.

To review live data:

1. Ensure that the **Pause Buffer Size** (see the *Output section* in Configure system processing parameters on page 109) and **Live data range** (see Live data range on page 217) are as required. All data exported during live review is displayed according to the Live data range.
2. Pause live data. To do this either:
   - Press the space bar; or
   - On the right of the time bar, click **Enter Review**.

   Live data is paused and on the right of the time bar at the bottom of the Workspace buttons are displayed that enable you to move through the paused data.
3. Use the time bar controls to move through the paused data as required:
   - To play or stop the replay of the paused data, click the Play / Stop button  /  on the right of the time bar.
   - To view a particular part of the data, drag the slider along the time bar.
   - To move through the paused data one frame at a time, click the Previous Frame  or Next Frame  buttons, or press the A or S keys.
   - To replay continuously, click the Loop button  .

3. To exit review mode, press the space bar again or click the **Exit Review** button to the right of the time bar.

> **Note**
> When reviewing live data, you can save what is displayed in the Live data range or in the Pause Buffer by right-clicking on **Exit Review** and selecting **Save live review data**.

Review captures

You load and play recorded captures using the **Review** panel (**View** > **Review**).

To play back captures:

1. In the **Review** panel, in the **Review Options** section, ensure that the relevant folder is selected, depending on the location of the capture you want to load. All captures in the specified folder are listed in the **Captures** section below. To manage the review folder, see Review Options on page 251 below.
2. In the **Captures** section, double-click the name of the required capture to load.
   You can identify that you are in Review mode in three ways:
   a. **Review** *CaptureName* is displayed in the menu bar.
   b. The menu bar changes color to distinguish between live and review modes.
   c. A time bar appears at the bottom of the Workspace view pane.

   The **System** panel displays all devices that were present when the data was captured. The lists of devices are the same as they were when the data was captured, but no settings are displayed in the bottom part of the panel. Any device warning information that was displayed when the devices were live is also displayed.
   The **Tracking** panel displays a list of all the top-level tracking objects that were present when the data was captured.
   No settings for the objects are displayed.
3. Use the time bar controls to move through the capture as required:
   - To play or stop the replay of the recorded capture, click the Play / Stop button  /  on the right of the time bar.
   - To view a particular part of the capture, drag the slider along the time bar
   - To move through the capture one frame at a time, click the Previous Frame  or Next Frame  buttons, or press the A or S keys.
   - To replay continuously, click the Loop button  .
   - To return to Live mode, on the menu bar click the Close button  to the right of the Review *CaptureName* title.

Change the review options

At the top of the **Review** panel, the **Review Options** section provides options for folder synchronization and loading data.

- To synchronize the capture folder and the displayed review folder, select the button for folder synchronization  .
- To manually navigate to a capture folder, de-select the folder synchronization button and click the button to browse for a file location  .
- To choose whether you want to **Load Raw Analog Data** or **Load Raw Optical Data**, display the advanced settings  .

Monitoring system activity

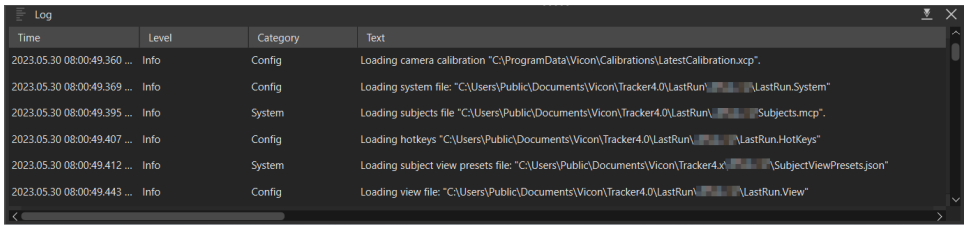
Tracker offers these ways to monitor system activity:

- System Health Report: You can monitor metrics related to overall system performance in the System Health Report.
- Log: You can view all activity of your Vicon system in the Log panel. You can access Log messages during any stage of the Tracker motion capture workflow.

For more information, see:

- System Health Report on page 164
- About the Log on page 253
- Work with the Log on page 254

About the Log



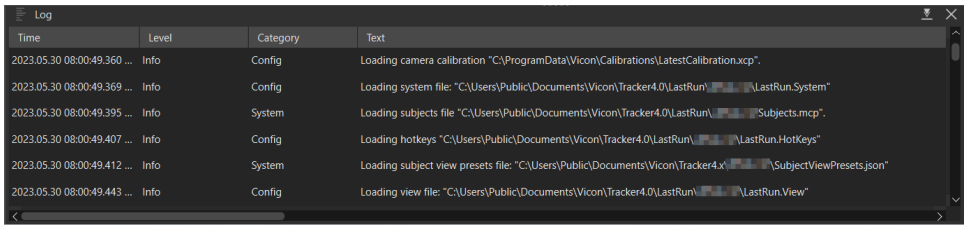
The **Log** consists of a single pane, which, by default, is displayed at the bottom of the Workspace. It displays a continual update of Tracker system activity since start up, as well as feedback on some motion capture and processing operations. Vicon Support may ask you for log information if you contact them to report a system problem.

If required, you can resize this pane, detach it from its current location, and move it to another location within the Tracker window.

The **Log** contains the following information:

Information type	Description
Time	The timestamp for the operation being executed in the date + time format (yyyy.mm.dd hh:mm:ss:fff format Note: +1 after the time denotes that the current time standard is in Daylight Savings Time
Level	Severity level of the message, which can be (from low to high in severity): Info (white), Warning (yellow), Error (red)
Category	The general Tracker function being performed, for example Capture, System, etc.
Text	The specific action and its success or failure.

Work with the Log



You can monitor the activity of your Vicon system in the **Log**. Its default position is at the bottom of the Tracker window.

A new log is written each time you start Tracker. New entries recorded during the current session are appended at the bottom of the log. You can copy all or part of the information in the log and save it to an external file, such as a Rich Text Format (.rtf) or plain text (.txt) file.

To monitor system activity:

1. In the **Log**, view the entries for system activity and processing operations.
2. Use the scroll bar to move down or back up the displayed entries.

To copy entries to external files:

1. Drag the cursor across the required entries.
2. Right-click and in the context menu click **Copy**. Tracker copies the text to the clipboard.
3. Open a text editor, such as Microsoft Notepad, and paste the copied text.

To filter the log, right-click in the **Log** pane and click **Advanced Options**.

Each log entry type can be filtered based on the following selections:

- Off – No entries
- Error – Error entries
- Warn – Warning entries
- Info – Information entries
- Default – All entries
- Global – Entries are controlled by the selection specified at the top of the Log options

If you want to display a log entry at a level not described above, contact Vicon Support[13].

You can also change scrolling behavior and delete and restore entries:

- Auto-scroll – Automatically scrolls to the bottom of the list of entries
- Clear – Deletes all entries from the Log
- Recover History – Restores previously deleted entries.

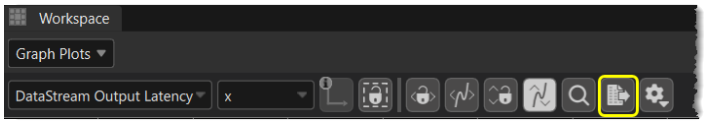
13 mailto:support@vicon.com

Exporting data to CSV

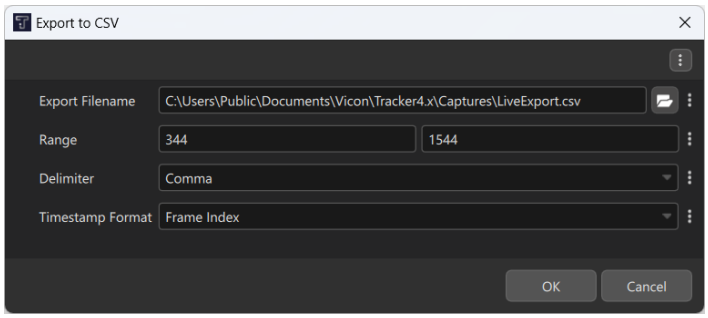
Tracker enables you to export the currently viewed graph plots as CSV (comma separated values) files. For information on graph plots, see Graphing your data on page 202.

To export data from graph plots to CSV:

1. Ensure that the data you want to export is currently displayed in the **Graph Plots** view, and that you are either reviewing an offline clip (see Review captures on page 250) or are reviewing live data (press the space bar or click the **Enter Review** button at the bottom right of the **Workspace**).
2. On the Graph Plots toolbar, click the **Export** button:



3. In the **Export to CSV** dialog box, make any required changes to the settings:



For information on the settings, see CSV export settings on page 257 and for details about what is exported, see About the exported data on page 259.

CSV export settings

The settings for CSV export are displayed in the **Export to CSV** dialog box, which is available from the Graph Plots view (see Exporting data to CSV on page 256).

- **Export Filename**: Enables you to view and change the current export path and filename
  - By default, the path and name are derived from the current capture name (live pause) or the name of the loaded review clip. To change the path and/or filename, browse to or enter the location and filename for the exported CSV file.
  - If analog channels that are running at a multiple of the system frame rate are included in the export selection, their data is saved into a separate file. This file is named: <fileName>*_devices_<device_frame_rate>Hz.csv*
  - If multiple devices at multiple frame rates are included, the data for each device is saved to its own separate file.
  - You may specify extensions other than *.csv*.
  - If the file(s) exists, you're given the option to overwrite or enter a new filename.
- **Range:** Enables you to specify the export frame range
  - If you have paused live data, the frame range is a function of the Live data range (see Change the scale of graphed data on page 216) and the Device Synchronization Session (see Tracker fundamentals on page 21).

    > **Tip**
    > To help interpret the range for paused live data, right-click on the x-axis label and make sure that **Relative Time Display** is not selected.

  - If you export data from an offline clip, the range corresponds to the length of the capture in frames.

- **Delimiter**: Enables you to select the separator of the data values in the export file, which can be:
  - Comma `(,)` – the default
    or
  - A tab
- **Timestamp Format**: Enables you to select the format of the timestamp value in the first column of the export data:
  - **FrameIndex** Produces two columns, giving the Vicon frame number, and sub frame corresponding to the sample (default). The first value corresponds to the frame number as displayed in the graph of the first sample of the selected range.
  - **Renumbered Frame Index** Gives the same output as FrameIndex, but renumbered to start from 1, where 1 corresponds to the first sample of the selected range.
  - **Time** Produces a single column showing the time of the sample in seconds.
  - **Renumbered Time** Shows the time of the sample, but starts the selected range at 0 seconds.

About the exported data

The data exported consists of the currently displayed components of the pinned and selected channels displayed in the graph window.

- The formats exported are as displayed in the graph. This applies to:
  - Units
  - Derivatives
- The data is exported as a single sample per line, with channel components (ie, XYZ) as columns.
- The header rows are:
  - Channel Name
  - Component Name
  - Units
- Velocity channels are assigned to the row corresponding to the second sample of the window used to calculate the derivative.
  - The time value or frame number is half a sample greater than the actual time point of the velocity sample.
  - For information on how velocities are calculated, see Derivatives on page 229 in the *Graph Plots reference*.

You can also export data to CSV via the Vicon Tracker API. For details of how to use the API, see the API documentation and example scripts in the *Vicon Tracker Python API Quick Start Guide*.

Extending your use of Vicon Tracker

In addition to using Tracker as part of a Vicon system as described in Prepare your Vicon Tracker system on page 8, you can:

- Use the Vicon Control app, to set up, calibrate, and capture with a Vicon Vantage system (see Use the Vicon Control app with Tracker on page 261).
- Stream data from Tracker over UDP using the Open Sound Control (OSC) (see Stream data using Open Sound Control on page 264).
- Use Tracker's built-in VRPN server (see Work with VRPN on page 270).
- Use the Vicon DataStream SDK (or UDP) to access Vicon Tracker data from Simulink (see Access Vicon Tracker data from Simulink on page 271).

Use the Vicon Control app with Tracker

Vicon Control connects wirelessly to Vicon Tracker and streams camera data to your mobile or tablet, enabling a single user to change camera settings, calibrate the system, and start or stop capture from anywhere in the volume.

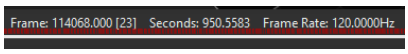
Vicon Control is support on both iOS and android operating systems.

Before you can use your device to Tracker, you must pair it with the PC that is running Tracker (the Vicon host PC).

Connect Vicon Control

To connect a device running the Vicon Control app to Tracker on a Vicon host PC:

1. Ensure that your device is connected to a Wifi access point that is on the same subnet as the Vicon host PC.
2. On the Vicon host PC, ensure that the required connection is used, that Tracker is running, and the system is connected.

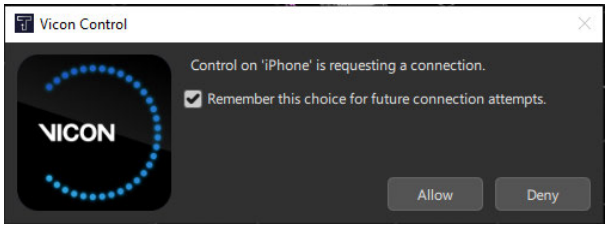


3. On the device, open the Vicon Control app.
   The connection to Tracker is displayed on the initial Control screen:

> **Tip**
> If you don't see your system listed, you can click **Connect Manually** and enter the IP address of the PC running Tracker.

4. Tap the Tracker icon.
   You are alerted that you must authorize the connection on the Vicon host PC before you can continue.

   In Tracker on the Vicon host PC, an authorization request is displayed:



5. To use the same connection in future, select **Remember this choice for future connection attempts**. To permit Control to access Tracker, click **Allow**.

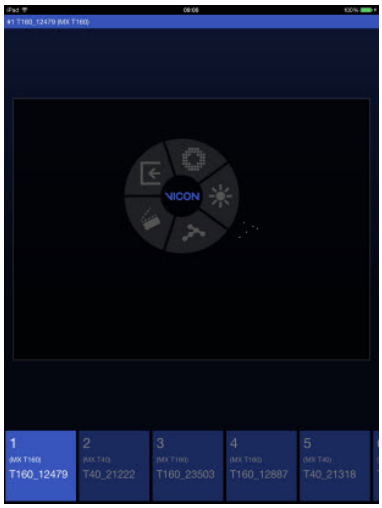
> **Tip**
> If later you need to revoke authorizations for Vicon Control, on the **Settings** menu in Tracker, click **Control Authorizations** and in the **Manage Control Authorizations** dialog box, click **Reset**. This revokes all stored authorizations.

   On the device, a screen similar to the following is displayed:

6. To select a camera and display a camera view, tap at the bottom of the screen.

   You can swipe the camera view right or left to change to the next or previous camera and use stretch and pinch as normal to zoom in and out.

   To access the dial control, tap and hold in a selected camera view.



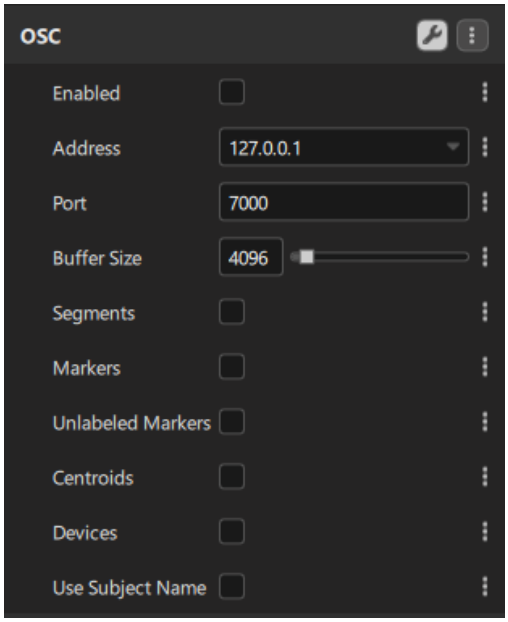
   Use the dial to view and change settings, calibrate and capture.

Stream data using Open Sound Control

Tracker enables you to stream data from Tracker over UDP using the Open Sound Control (OSC) format, so that you can access live data in your OSC server application.

To access the OSC data streaming options:

1. On the **View menu**, ensure **Connections** is selected.
2. In the **Connections** panel, go to the **Output Settings** properties to find the **OSC** section.
3. At the top right of the **OSC** section, ensure the Advanced properties are displayed.
   The data available for output is a subset of the data available using the DSSDK.



> **Important:**
> To stream device data, you must give the device a name.

OSC stream properties

You can view or change these OSC streaming settings:

Property	Description
Enabled	Turns streaming on or off
Address	Address used to create the outbound socket
Port	Port number used to create the outbound socket
Buffer Size	Size of the buffer to allocate to store a frame's worth of data
Objects, Markers, Unlabeled Markers, Centroids, Devices	Turn on/off output for the specified data types
Use Object Name	If a single subject is loaded, this option enables you turn on/off the subject name in the output message address (see Packet contents on page 265). If multiple subjects are loaded, the subject name is always included as part of the message address.

Packet contents

Each packet consists of a bundle containing one or more messages. Each message has an address associated with it to identify its contents. The **/vicon/frame** message is always generated; other messages may or may not be present, depending on the output data types selected.

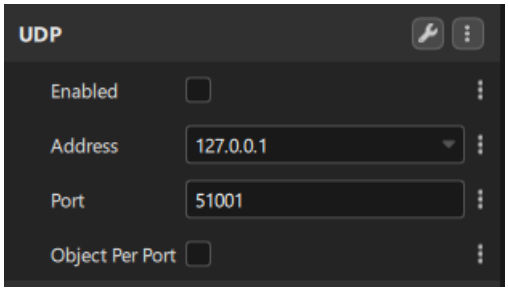
Full address (Base in bold)	Tracker property	DSSDK type	Data values	Description
/vicon/frame	NA	Output_GetFrameNumber Output_GetFrameRate Output_GetTimecode	long - Frame Number float - Frame Rate int32 - Timecode Hours int32 - Timecode Minutes int32 - Timecode Seconds int32 - Timecode Frames int32 - Timecode Subframes int32 - Timecode Field Flag int32 - Timecode Standard int32 - Timecode SubframesPerFrame int32 - Timecode UserBits	Always present in the bundle. Timecode values are only present if the application has timecode enabled.
/vicon/seg/ SUBJECT/ SEG_NAME /vicon/seg/ SEG_NAME	Enable Segments	Output_GetSegmentGlobalTranslation Output_GetSegmentGlobalRotationMatrix	float(3) - Translation float(9) - Rotation matrix	SUBJECT: Subject Name SEG_NAME: Name of the segment If the Subject Name property is cleared and a single subject is loaded, the SUBJECT portion of the address is omitted. In all other cases it is present.
/vicon/marker/ SUBJECT/ MARKER_NAME /vicon/marker/ MARKER_NAME	Enable Markers	Output_GetMarkerGlobalTranslation	float(3) - Translation	SUBJECT: Subject Name MARKER_NAME: Name of the marker If the Subject Name property is cleared and a single subject is loaded, the SUBJECT portion of the address is omitted. In all other cases it is present.

Full address (Base in bold)	Tracker property	DSSDK type	Data values	Description
/vicon/unlabeled /N	Enable Unlabeled Markers	Output_GetUnlabeledMarkerGlobalTranslation	float(3) - Translation	N: A number starting at 0 Unlabeled marker numbers are arbitrary so you can't assume that the same unlabeled marker will be given the same number frame-to-frame.
/vicon/2D/ CameraID	Enable Centroids	Output_GetCentroidPosition	int32 - Number of centroids For each centroid: float(2) - Position float - Radius	
/vicon/device/ NAME/OUTPUT/ COMPONENT	Enable Devices	Output_GetDeviceOutputValue	int32 - Number of samples For each sample: float - Device output value	NAME: Device name OUTPUT: Device output name COMPONENT: Device output component name

Stream object data over a UDP broadcast connection

The UDP Object stream is a Vicon protocol for streaming simple object data over a UDP broadcast connection, for interaction with applications such as Simulink, in situations where using the TCP DataStream is not possible. (See also Access Vicon Tracker data from Simulink on page 271.)

Specify UDP object streaming protocol properties



To access the UDP object streaming protocol settings:

1. On the **View menu**, ensure **Connections** is selected.
2. Within the Connections Panel, look at the **Output Settings** properties to find the **UDP** section.
3. At the top right of the section, ensure the **Advanced** properties are displayed.

You can view or change these UDP Object Streaming Protocol settings:

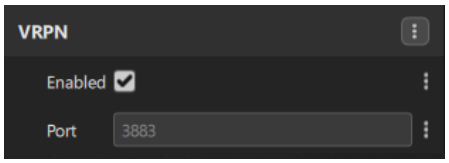
Setting	Description
Enabled	If selected, starts the UDP streaming of data. Unlike the data stream, the UDP stream does not maintain client connection information. If selected, data is output whether or not there are any connected clients.
Address	The network address used to broadcast the data.
Port	The starting port for UDP streaming. If **Object Per Port** is selected, this is the starting port number. If **Object Per Port** is cleared, this is the output port for all objects.
Block Size	The size of the UDP datagrams (data blocks). Ensure the value selected matches the expected value for the datagram size in the client program. Options are 256, 512, and 1024.
Object Per Port	If cleared, all objects are output on the same port. If selected, each object is output on its own UDP port. Port assignments are made whether or not the object is active.

Work with VRPN

The Virtual-Reality Peripheral Network (VRPN) is a library that provides an interface between 3D immersive applications and tracking systems used for Virtools. Vicon Tracker has a built-in VRPN server that streams data natively into these applications or will enable the development of simple interfaces using VRPN.

To turn VRPN output on or off:

1. On the **View menu**, ensure **Connections** is selected.
2. In the Connections panel scroll within the **Output Setting** to the **VRPN** section's properties.
3. Select or clear the **Enabled** check box (selected by default).



Access Vicon Tracker data from Simulink

If you are working in an environment that supports the use of the Vicon DataStream SDK (where TCP/IP is supported), you can use the SDK from within a Simulink block (S-function) to access data streamed from Vicon Tracker.

In addition, Vicon Tracker 4 includes a UDP stream that contains object translation and rotation data. If you are working in an environment that supports only UDP and therefore cannot use the Vicon DataStream SDK to access Tracker object data from Simulink, you can access Tracker positional data from the UDP stream.

> **Important**
> The UDP stream contains only a small subset of the data that is available via the Vicon DataStream SDK, so if possible, use the Vicon DataStream SDK in preference to the UDP stream.

To help you access Tracker data from Simulink, examples of both types of access are installed with Tracker. They can be found in the following default location:

C:\Program Files\Vicon\Tracker4.#\Simulink

For more information, see:

- Prerequisites for using Simulink with Vicon Tracker on page 272
- About the UDP stream on page 273
- About the Simulink examples provided with Vicon Tracker on page 276
- How to run the Simulink examples on page 278

Prerequisites for using Simulink with Vicon Tracker

To use Simulink with Tracker, ensure the following requirements are met:

- You are familiar with Simulink.
- For compiled S-functions, access to and proper configuration of a compiler in MATLAB.

  Tip

  You can use configurations other than compiled S-functions (such as using MATLAB code within the Simulink block) but there may be a performance disadvantage to using interpreted code. Alternative configurations have not been investigated or tested by Vicon.

- A properly installed C or C++ compiler. Microsoft Visual Studio 2013 was used during the development of the examples and the workflow has since been tested with Microsoft Visual Studio 2019.
- Installed and licensed Instrument Control Toolbox. This toolbox is licensed separately (i.e. it is not part of the Simulink license). It is needed for receiving UDP packets only.

About the UDP stream

The UDP stream outputs translation and rotation information for active objects in Vicon Tracker.

To access data from this stream you must write a 'client' to access the stream and parse the data block to access its contents. The example clients provided with Tracker illustrate the block parsing and some possible configurations for block outputs.

For each frame in Tracker, one or more data blocks are sent. The number of blocks per frame sent is dependent on:

- The data block size setting
- The number of active objects
- The object-per-port setting

The UDP stream parameters are displayed in the **Connections** panel, in the **UDP** section.

Properties from this section are stored in the *.system* file.

Example UDP Packet contents table

The following UDP Packet contents table provides more technical detail about the layout and content of the UDP stream. You may find this useful if, for example, you want to use the UDP stream, but do not want to use it with Simulink. It is taken from *DataBlock.h*, which is one of the Simulink example files.

Byte offset	Content	Comment
0-3	Frame Number	nnnn
4	ItemsInBlock	2
5	ItemHeader:ItemID	0 (0 for object data. Other object types not currently supported.)
6-7	ItemHeader:ItemDataSize	72
8-31	TrackerObject:ItemName	'O''b''j''e''c''t''1'00000000000000000
32-39	TrackerObject:TransX	
40-47	TrackerObject:TransY	
48-55	TrackerObject:TransZ	
56-63	TrackerObject:RotX	
64-71	TrackerObject:RotY	
72-79	TrackerObject:RotZ	
80	ItemHeader:ItemID	0 (0 for object data. Other object types not currently supported.)
81-82	ItemHeader:ItemDataSize	72
83-106	TrackerObject:ItemName	'O''b''j''e''c''t''2'00000000000000000
107-114	TrackerObject:TransX	
115-122	TrackerObject:TransY	
123-130	TrackerObject:TransZ	
131-138	TrackerObject:RotX	
139-146	TrackerObject:RotY	
147-154	TrackerObject:RotZ	

Object data output by the UDP stream

Data that is output matches the Vicon DataStream SDK values for the same frame. The UDP stream contains no axis mapping options.
For each object six values are output:

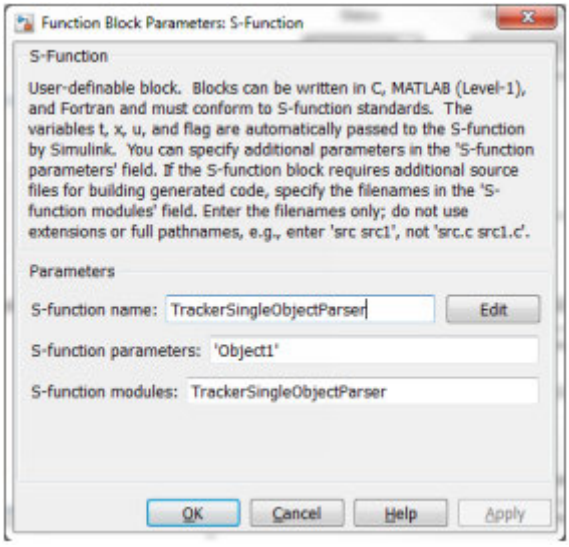
- Translation X, Y, and Z
  The values match the values received from GetSegmentGlobalTranslation through the Vicon DataStream SDK.
- Rotation X, Y, and Z
  The values match the values received from GetSegmentGlobalRotationEulerXYZ through the Vicon DataStream SDK.

About the Simulink examples provided with Vicon Tracker

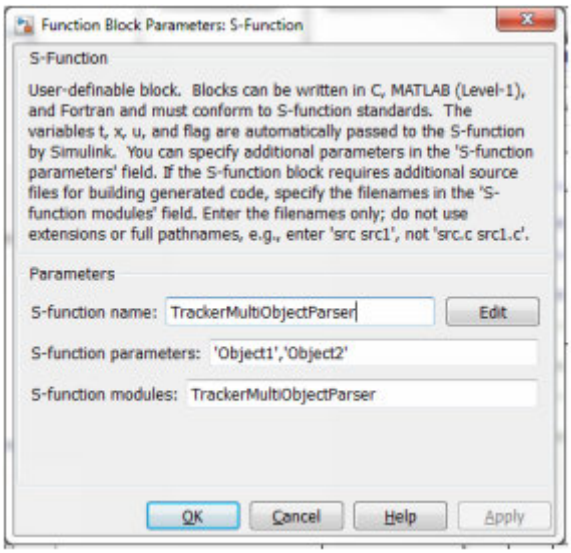
All of the examples consist of an S-function along with a Simulink model showing a block using the custom S-function in a simulation. Note the following points:

- Simulink models are stored in files with a .mdl extension
- Examples were developed and tested using 64-bit versions of MATLAB/ Simulink/Vicon DataStream SDK. (You cannot mix 32- and 64-bit code.)
- Single object and multiple object examples on the same port are provided using the Vicon DataStream SDK as well as the UDP stream. The only difference in these examples is the method of data access.
- An additional example for the UDP stream is provided, which illustrates the Object Per Port functionality. This functionality is not available using the Vicon DataStream SDK.
- The examples use block parameters to specify the object names to be output.
  - String parameters are surrounded by single quotes.
  - Multiple parameters are separated by commas.
  - To access block parameters, double-click on the block in the model.

Single block parameter:



Multiple block parameters:



How to run the Simulink examples

The following steps described how to run one of the Simulink examples provided with Vicon Tracker, which demonstrate how to obtain Vicon Tracker data from Simulink.

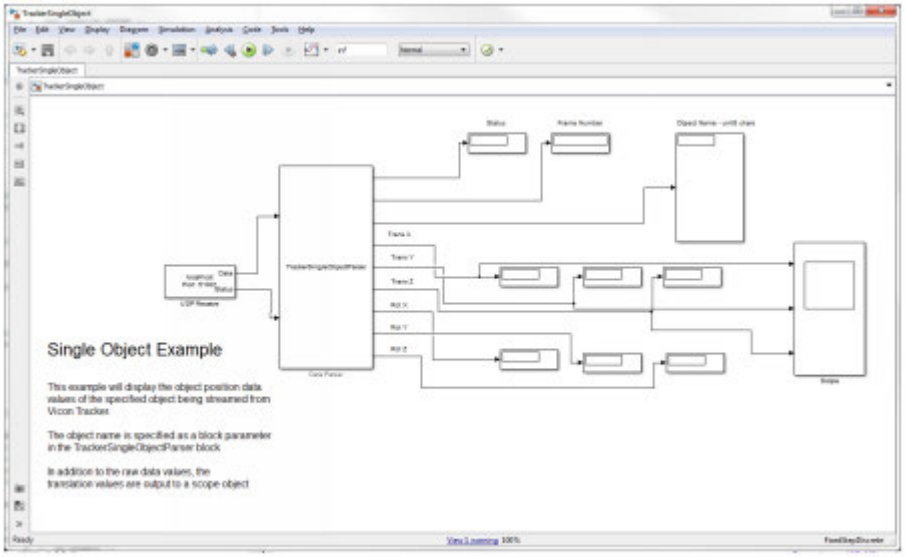
> **Important**
> When you compile the code for the custom blocks, files are created in the same folder as your source file. It is recommended that you copy the example files to a folder other than the Tracker installation folder before compiling, running, or modifying the example files.

To run an example:

1. Ensure Tracker is running and streaming data.
2. The examples reference objects named Object1 and/or Object2. If you need to change the objects that are displayed, modify the block parameters to reference the desired object(s).
3. Open MATLAB.
   A MATLAB window similar to the following is displayed:

4. Change your current folder to one containing the example you want to run.
5. Compile the example file. For more information, see the specific compile information below. Vicon DataStream SDK examples need to link in the proper Vicon DataStream SDK file as well.
6. Load the model by dragging the desired .mdl file from the file listing to the command window.

This issues a uiopen command passing in the file you are dragging and opens the model window.



7. In the model window click the Play button to run the simulation.

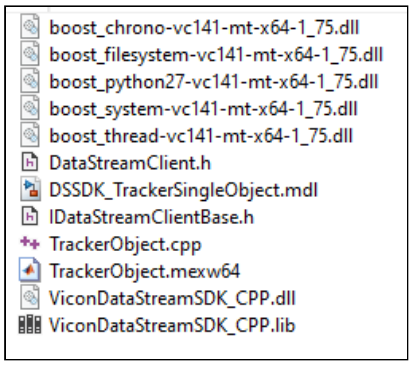
> **Tip**
>
> If the model contains a scope block to draw a graph of the data, you must double-click on the scope to open it – it does not open automatically.

Vicon DataStream SDK examples

Before you use any of the Vicon DataStream SDK examples, they must be compiled and linked with the Vicon DataStream SDK.

To compile and link the Vicon DataStream SDK examples:

1. Copy the CPP files from the Vicon DataStream SDK installation folder to the folder containing the example files.
   Your file names might be slightly different from those in the following illustration, depending on the version of the Vicon DataStream SDK you are using.



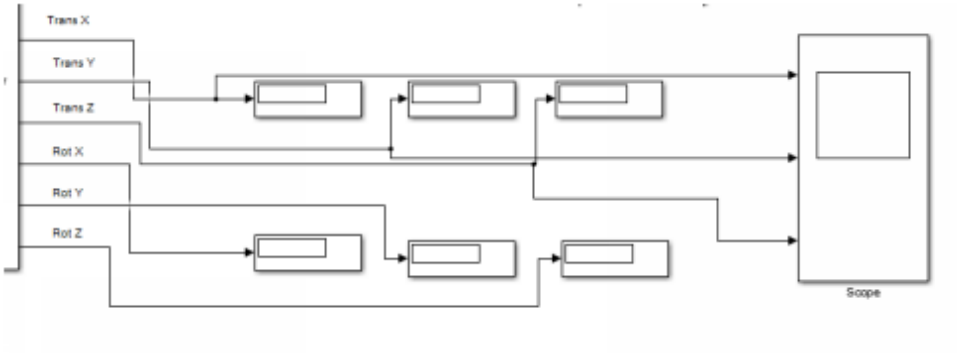
2. To compile and link C++ code, use the mex command. You need to compile the *.cpp* file and then link it with the Vicon DataStream SDK .lib file. You can do this in a single step that looks like this

```
>> mex TrackerObject.cpp ViconDataStreamSDK_CPP.lib
Building with 'Microsoft Visual C++ 2019'.
MEX completed successfully.
```

   Successful compilation results in the creation of a file with a *.mexw64* extension.

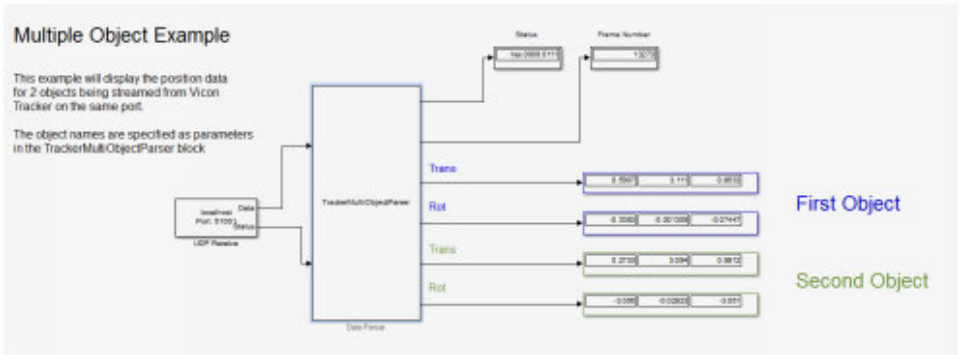
Vicon DataStream SDK SingleObject example

This example displays the positional information for an object (object name specified as block parameter). Each of the translation and rotation values is on a separate output.



Vicon DataStream SDK MultipleObjects example

This example displays the positional information for two objects (names specified as block parameters). Three values are provided for each of the four defined outputs.



UDP stream examples

All examples use the Instrument Control Toolbox receiving UDP packets. This toolbox is licensed separately (i.e. it is not part of the Simulink license).

All of the example S-functions have been written in C. Before using any of these examples, they must be compiled.

To compile the examples:

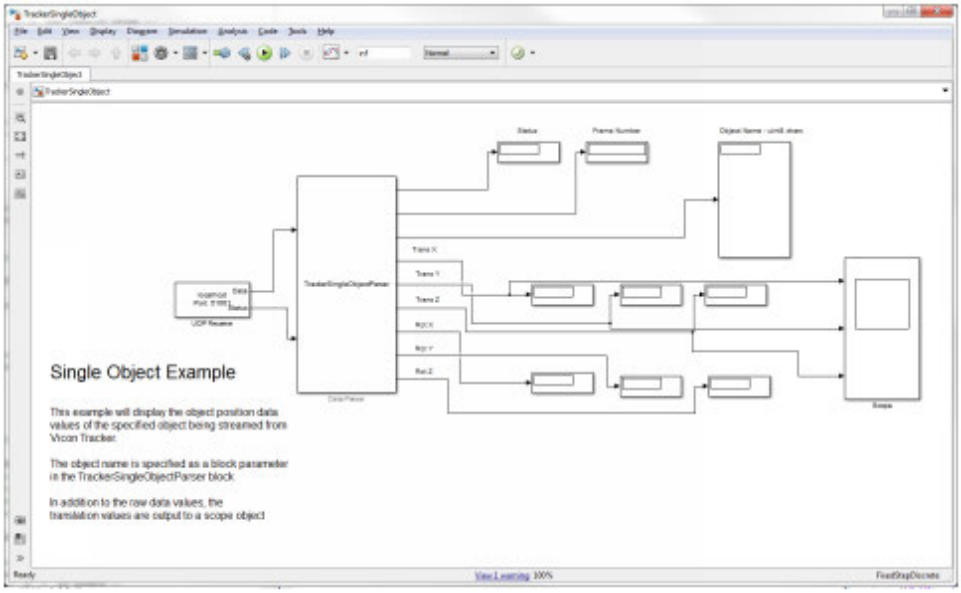
- To compile C code, use the mex command, supplying the name of the .c file as input, as follows:

```
>> mex TrackerSingleObjectParser.c
Building with 'Microsoft Visual C++ 2012 (C)'.
MEX completed successfully.
```

ObjectPerPort folder

This folder contains two models:
TrackerSingleObject.mdl and TrackerMultipleObjects.mdl

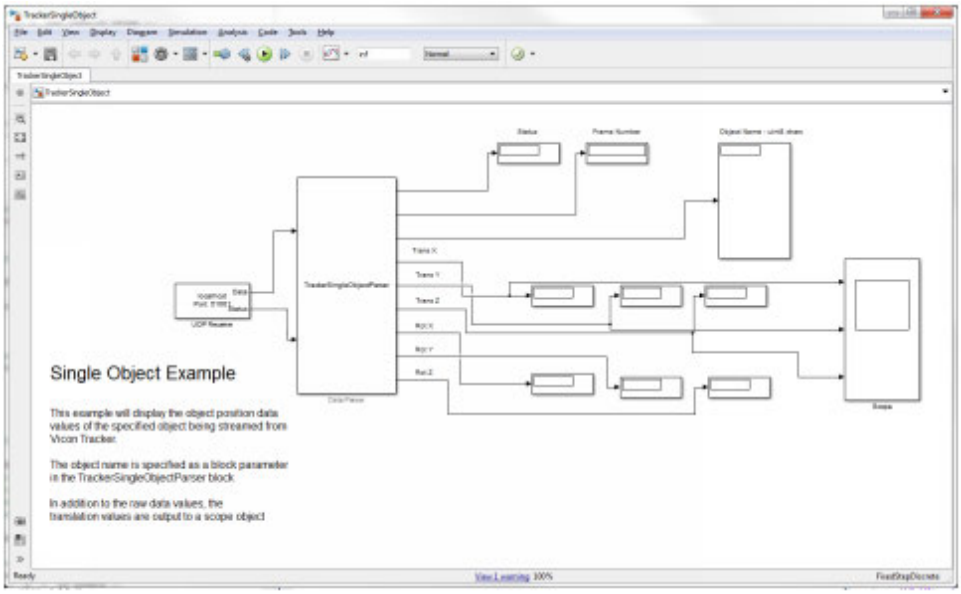
Both models use the same custom S-function, TrackerSingleObjectParser. The object parsing function looks for the object name passed in as a block parameter and displays the positional information for the object. Each of the translation and rotation values is on a separate output.



You must configure the UDP Receive blocks in the models to match Tracker output with regard to data block size and port numbers.

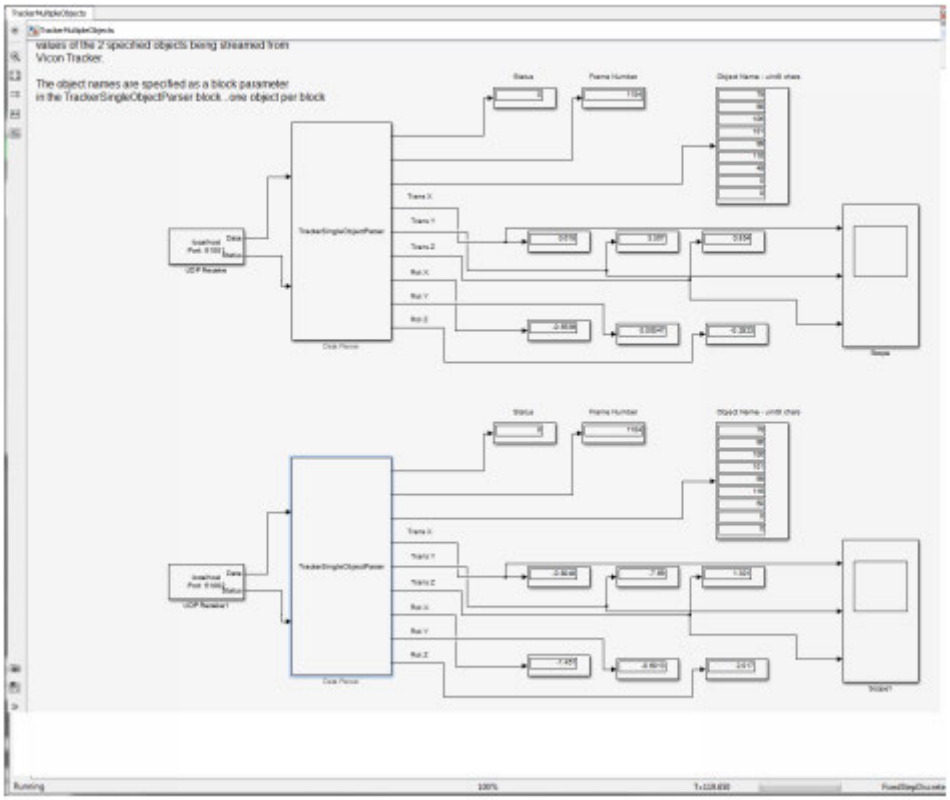
UDP stream TrackerSingleObject example

This example displays the positional information for an object (object name specified as block parameter). Each of the translation and rotation values is on a separate output.



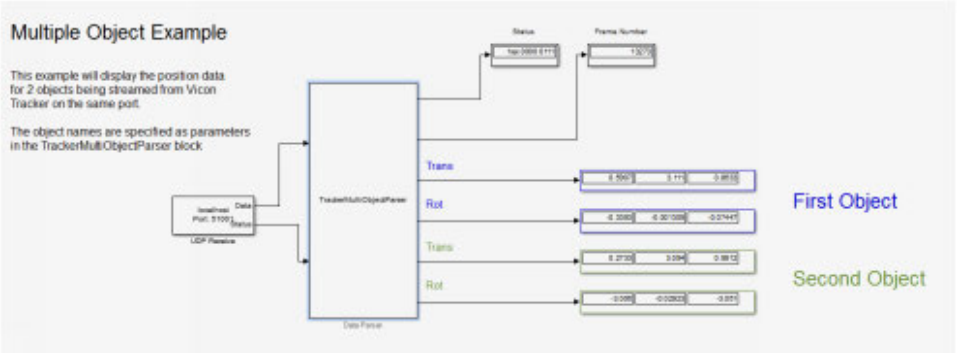
UDP stream TrackerMultipleObjects example

This model has two UDP receive blocks to receive data from Tracker, using the Object Per Port option.



UDP stream MultipleObjectsSamePort example

This example displays the positional information for two objects (object names specified as block parameters). Three values are provided for each of the four defined outputs.



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